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MHU 79/C CLIP-IN ASSEMBLY

(UNIVERSAL CLIP-IN)

George Lorimer

Edward Freyman

Rock Island Arsenal

Rock Island, Illinois

Contract AF(29-601)-65-PO-2

TECHNICAL REPORT NO. AFWL-TR-67-38

January 1968

AIR FORCE WEAPONS LABORATORY
Air Force Systems Command
Kirtland Air Force Base
New Mexico

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FOREWORD

This report was prepared by the U. S. Army Rock Island Arsenal, Rock Island, Illinois, Under Contract AF(29-601)-65-PO-2.

The research was performed under Program Element 6.24.05.06.F, Project 5704-00-004.

Inclusive dates of research were November 1964 to September 1967. The report was submitted 22 November 1967 by the Air Force Weapons Laboratory Project Officer, Captain James G. Burton (WLDM).

This report has been reviewed and is approved.

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ABSTRACT

(Distribution Limitation Statement No. 2)

This final report summarizes the engineering effort of Rock Island Arsenal to design a Universal Clip-in and associated equipment for the Air Force Weapons Laboratory (AFWL), to accommodate a variety of types and sizes of stores. Systems components and the problems inherent in designing them are described. Operating instructions are specified. The RIA test program is outlined and the results and chief features of the device are presented. This Universal Clip-In meets the Air Force requirements, and has been designated as the MHU 79/C Clip-In Assembly.

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ILLUSTRATIONS

ILLUSTRATIONS (Cont'd)

SECTION I

INTRODUCTION

The logic that justified the introduction of clip-in suspensions came with the era of jet aircraft. Aircraft servicing time between flights was reduced drastically, so that a prepackaged and prechecked set of stores for rapid transfer to the aircraft was highly desirable.

This clip-in concept has undergone a continuous expansion in the last several years. The design of the system furnished under the present contract with the Air Force Weapons Laboratory is an inverted "U" configuration, with a vertical row of stores attached to the inner sides of the legs of the "U." By adding a removable middle leg, one or two additional rows of stores may be carried. The components which support each store are adjustable vertically along the legs, thus adapting to various diameter stores. The number in each vertical row varies from two to four. This concept also requires telescoping sway brace arms to adapt to stores from 14 to 30 inches in diameter. By including the safety and checkout requirements applicable to nuclear weapons, the nomenclature aptly becomes "Universal Clip-In."

Considerable loading and ground handling equipment is necessary to permit full utilization of the clip-in. There must be one piece of equipment for bringing individual bombs to the clip-in, with sufficient flexibility to mate the bomb into the bomb rack. The lower bombs extend partly below the legs of the clip-in, so that it is desirable during loading to suspend the clip-in from an overhead

structure or loading stand. A powered trailer (MHU-33/M), having two long pick-up arms, engages a shallow skid (adapter) on which the loaded clip-in is emplaced for removal from the loading stand, transportation to the aircraft, and installation within the aircraft.

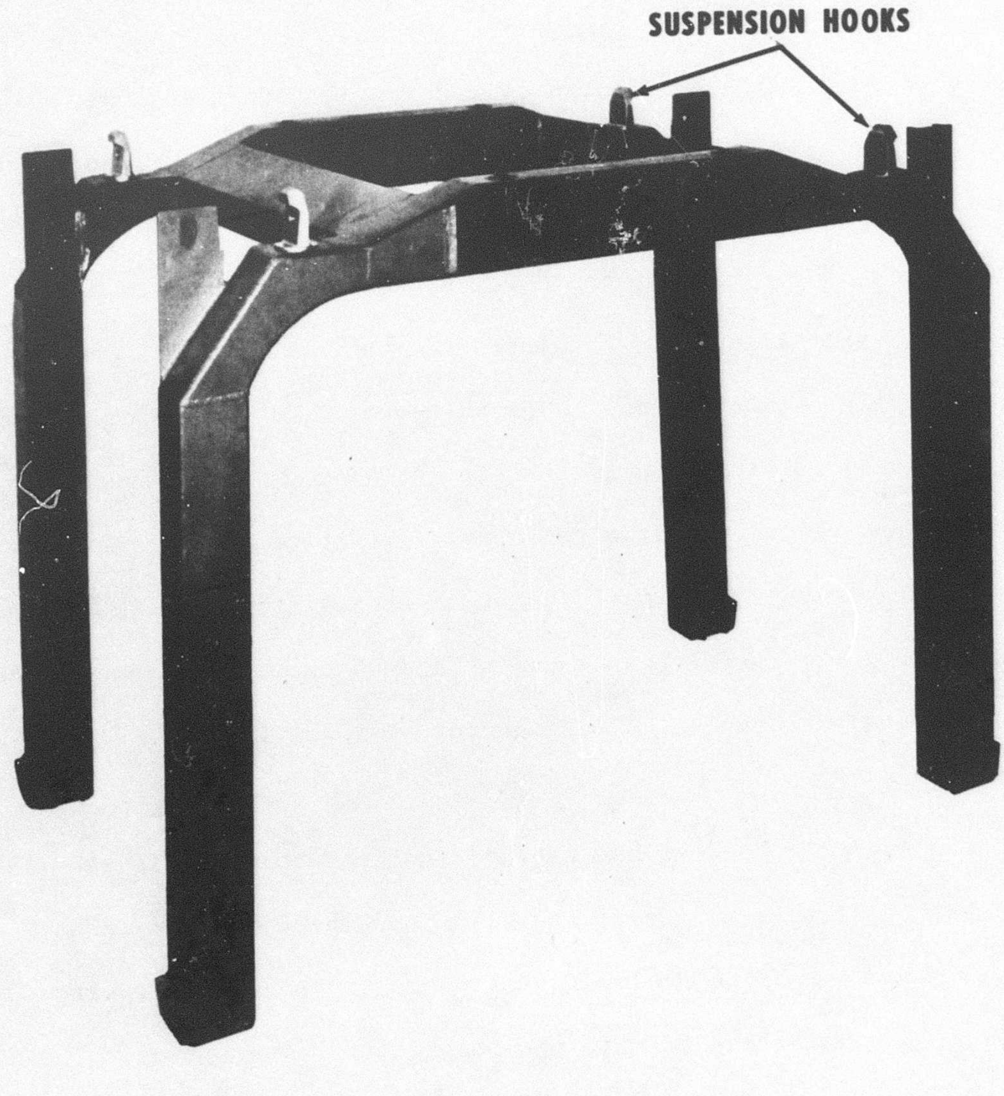

Figure 1

Frame Assembly for Universal Clip-In

SECTION II

GENERAL DESCRIPTION

The clip-in frame, the removable leg, and the assembly of these are shown in Figures 1, 2, and 3 respectively. Figure 1 also shows the four suspension hooks that mate with the MAU-6/A Rack (See Figure 14) that is carried in the B52 aircraft and accepts a wide variety of clip-ins. Each leg has a vertical channel along the inside which is used for adjusting the height of the bomb racks and sway braces (See Figure 4). The bomb rack (w/o one side plate) is shown in Figure 5, and the sway brace in Figure 6. The bomb racks and sway braces assembled with four 18-inch diameter dummy bombs are shown in Figures 7 and 8 (capacity is nine, but only four were available when the photograph was taken).

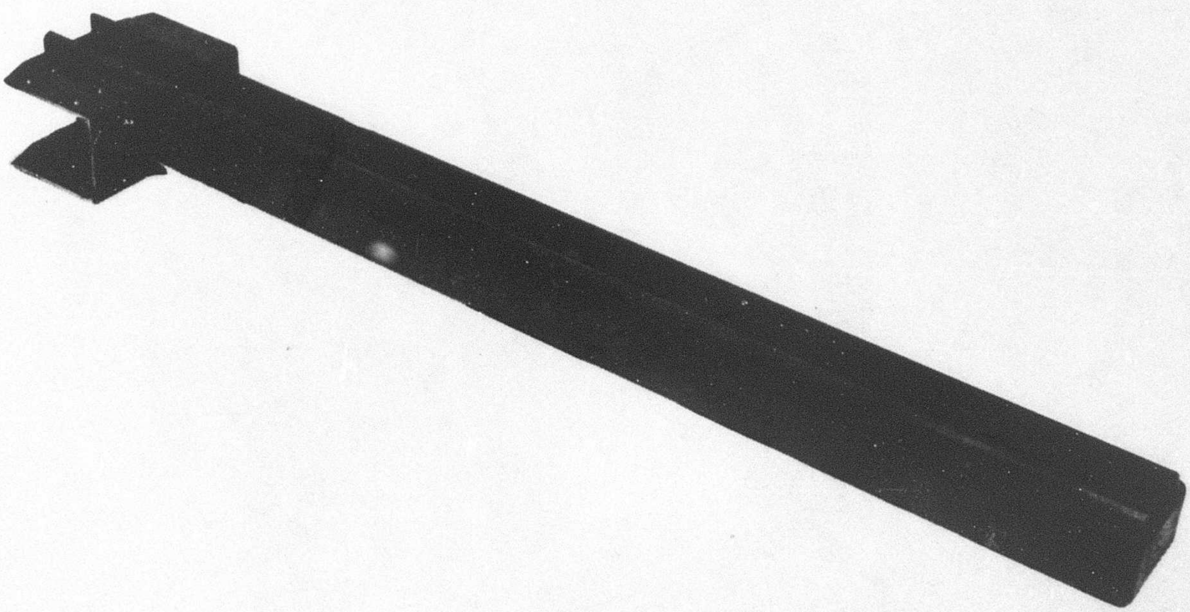

Figure 2
Removable Leg for Universai Clip-In

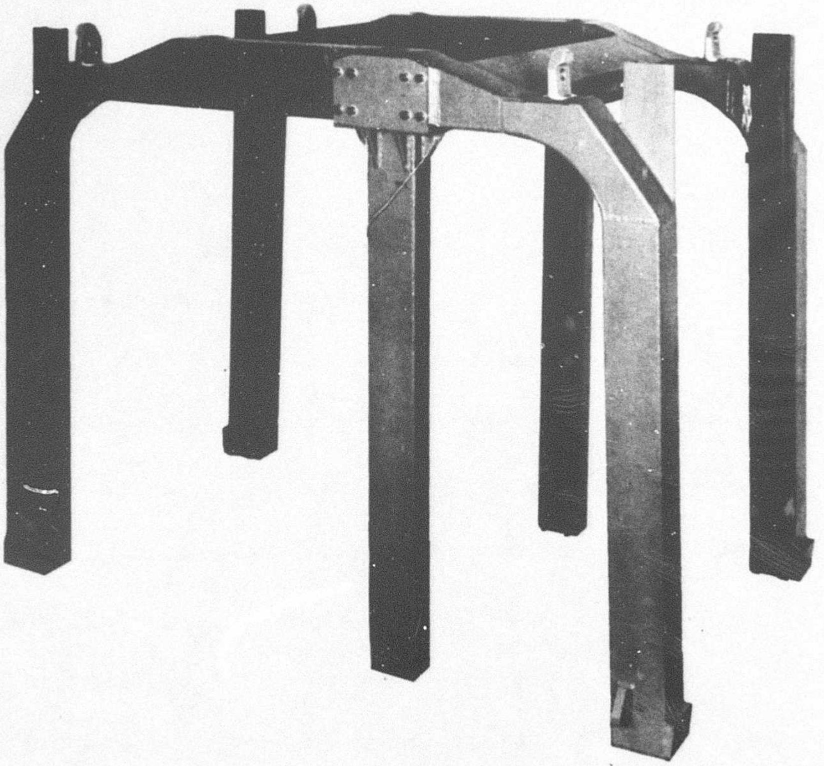

Figure 3
Frame Assembly with Removable Legs Attached

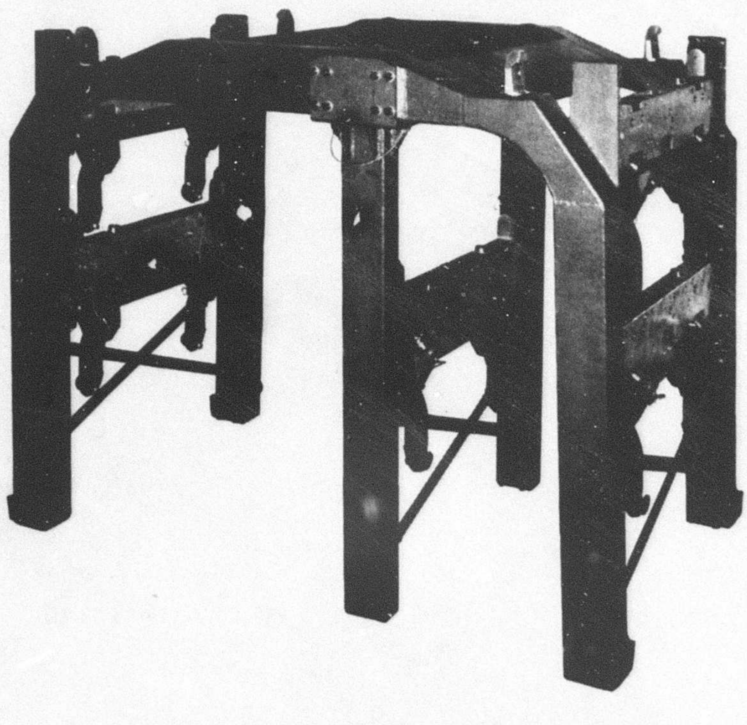

Figure 4
Frame Assy. with Removable Leg, Bomb Racks, & Sway Braces Assembled

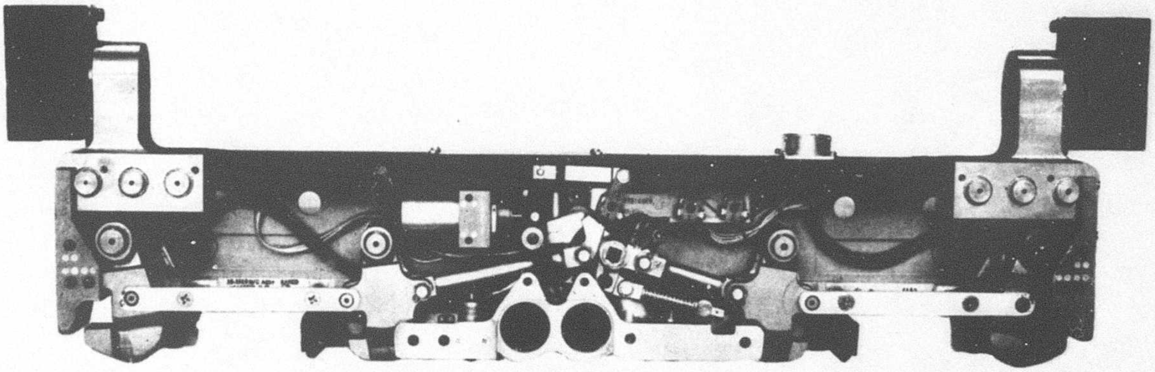

Figure 5
Bomb Rack With One Side Removed

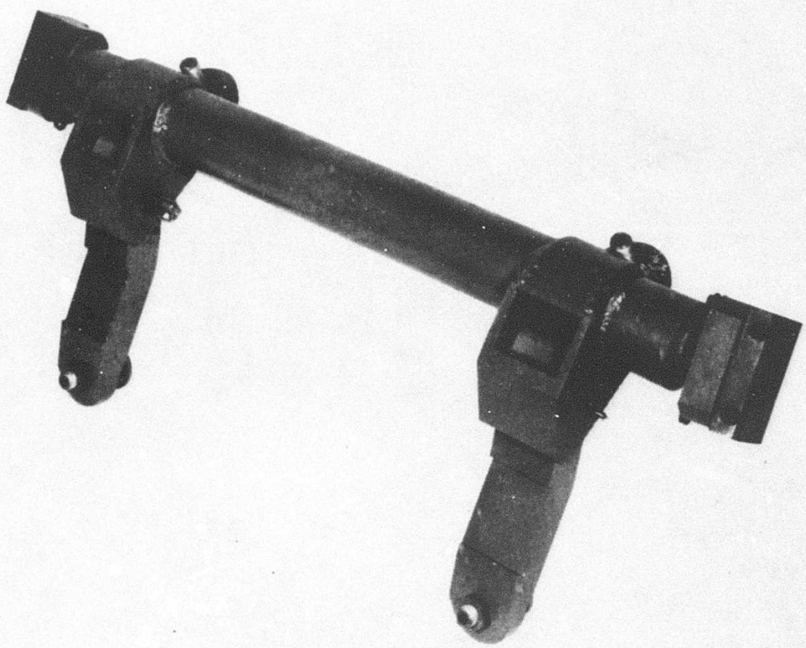

Figure 6
Sway Brace Assembly for Universal Clip-In

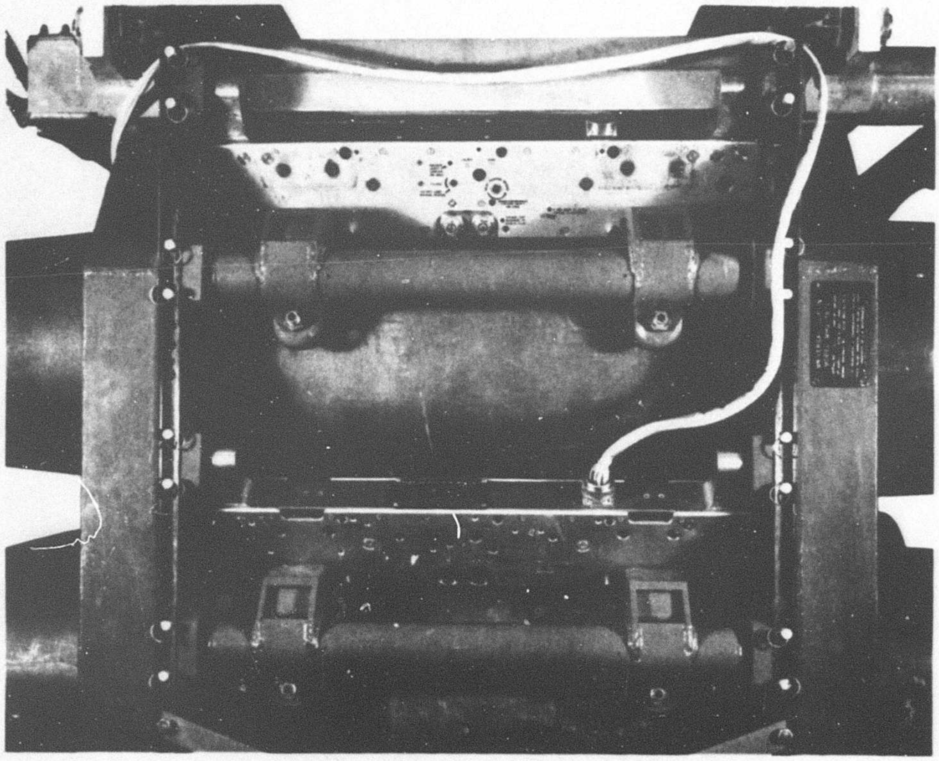

Figure 7
Universal Clip-In Bomb Racks & Sway Braces

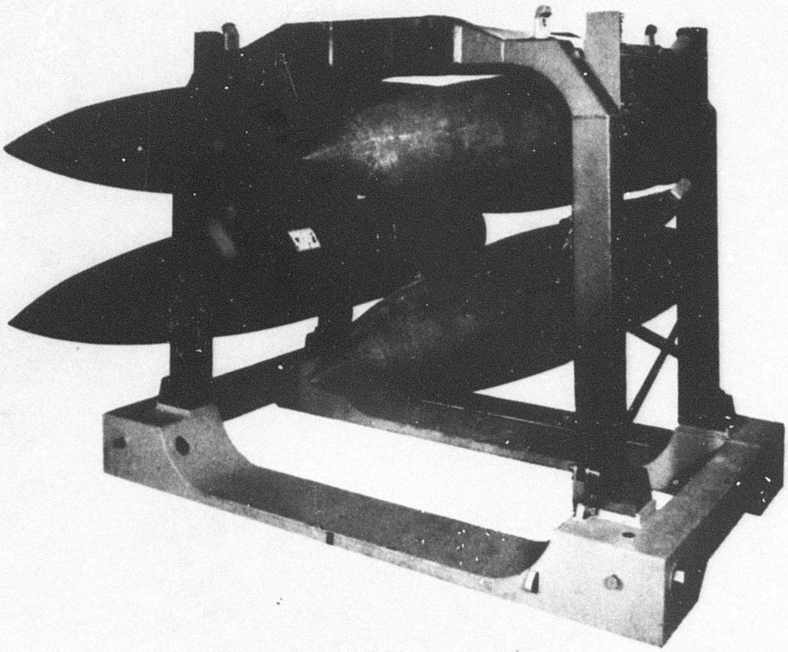

Figure 8
Universal Clip-In & Adapter With 18-Inch Dia. Dummy Stores

The following ground handling equipment is also furnished:

1. The loading adapter (Figure 9) is used as a carrying platform for the clip-in. Retractable arms permit lifting by the MHU-7/M (or MHU-33/M) trailer which is a standard inventory item of the Air Force (Figure 11). The clip-in mounts on this adapter in only one position due to keying pins of different diameters. Hold-down clamps are locked as shown in Figure 10. The adapter is purposely made shallow (vertically) so that it can be used to position a loaded clip-in beneath the B52 aircraft.

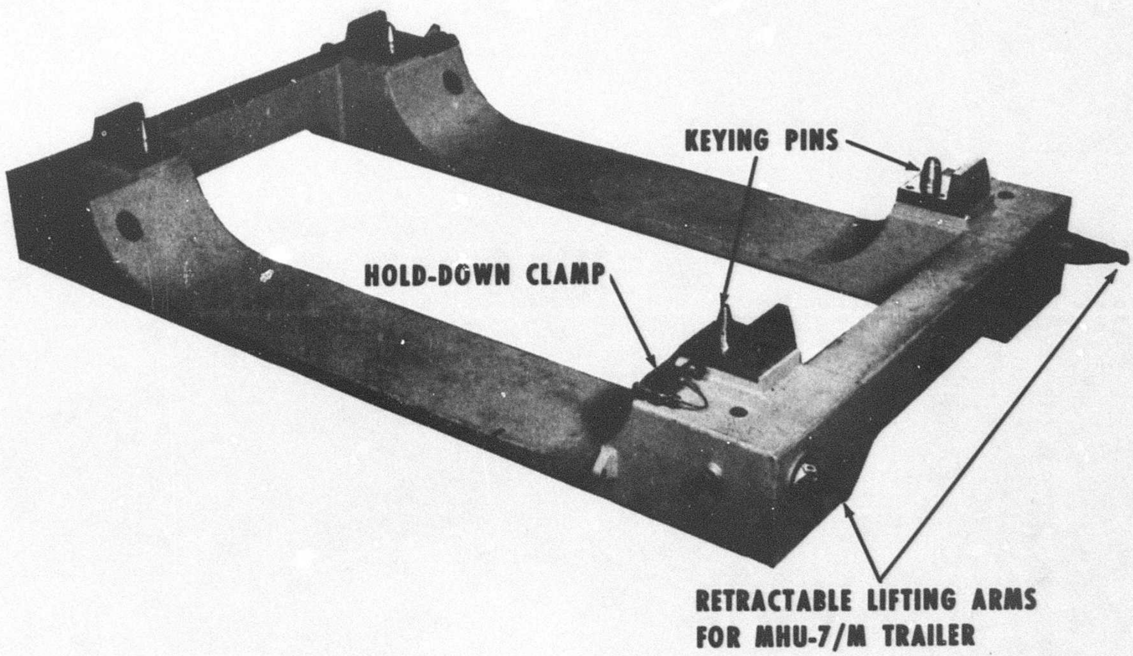

Figure 9
Adapter Assembly

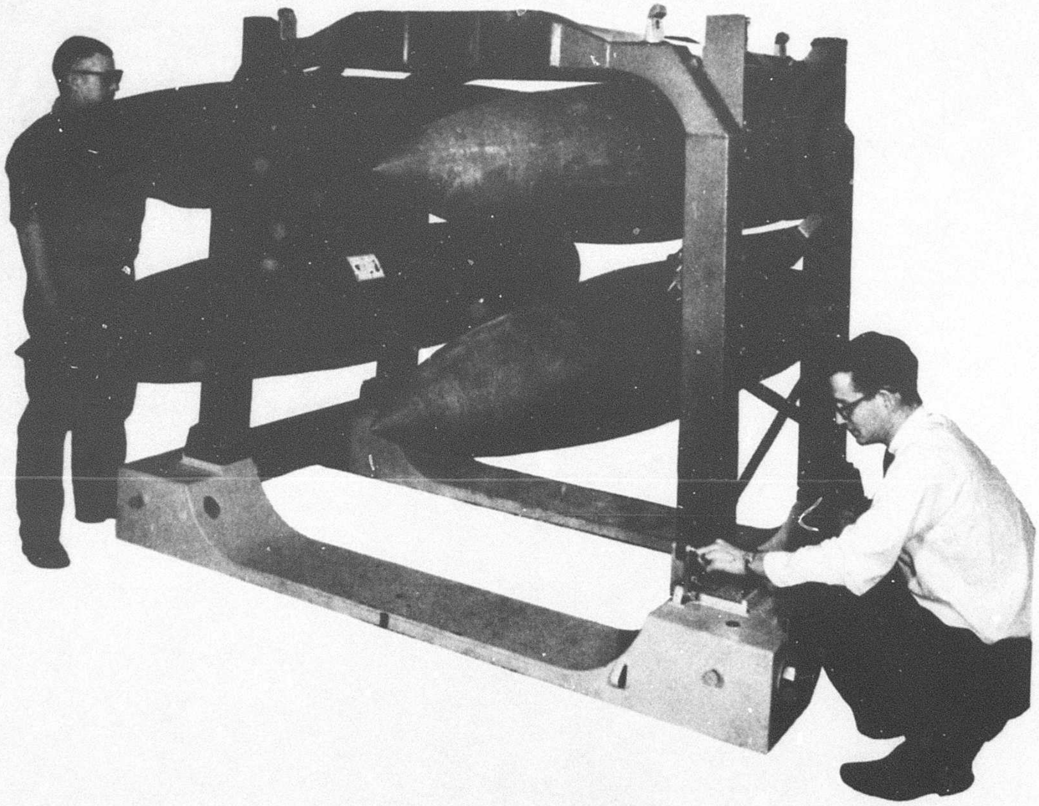

Figure 10
Universal Clip-In & Adapter With Dummy Stores

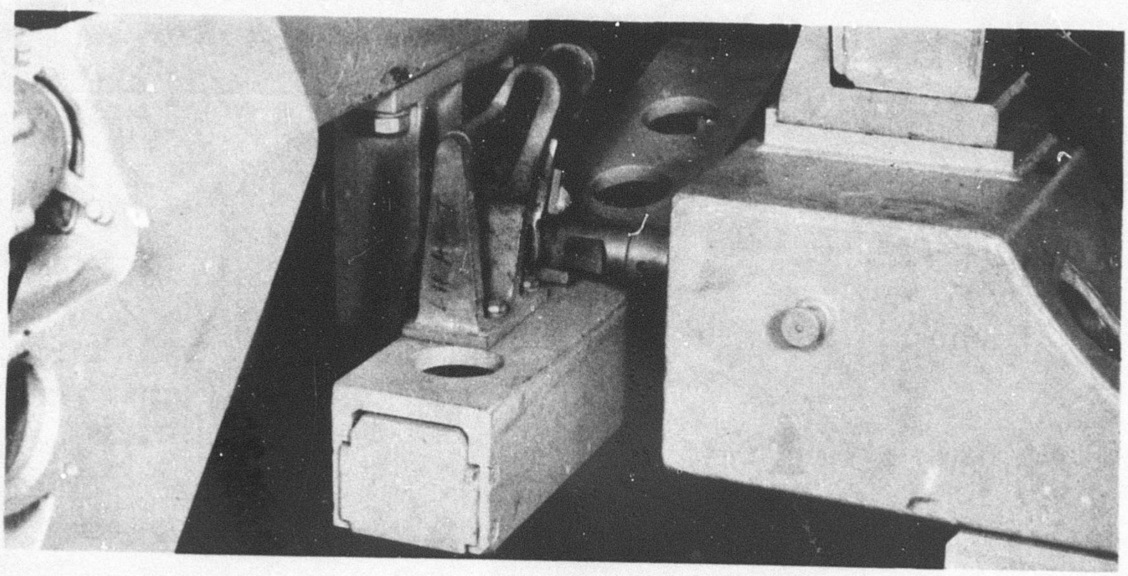

Figure 11
Mating Adapter & Clip-In to MHU-7/M Trailer

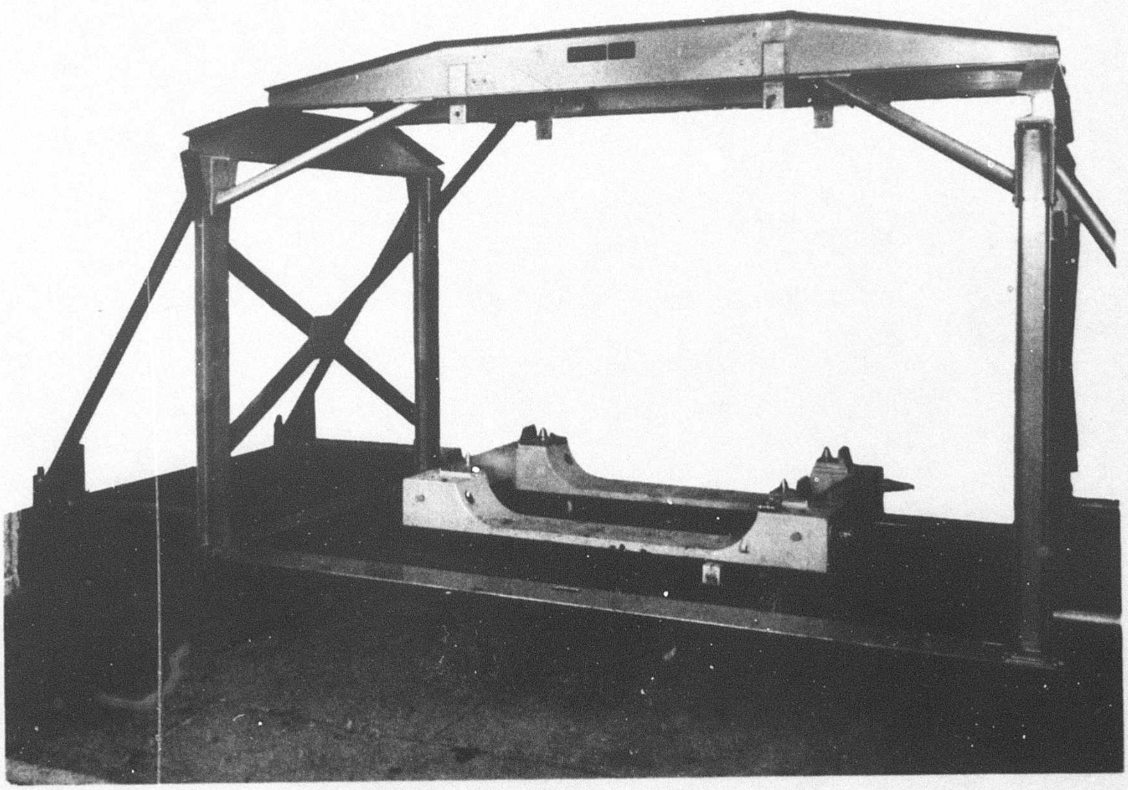

Figure 12
Loading Stand Assembly & Adapter Assembly

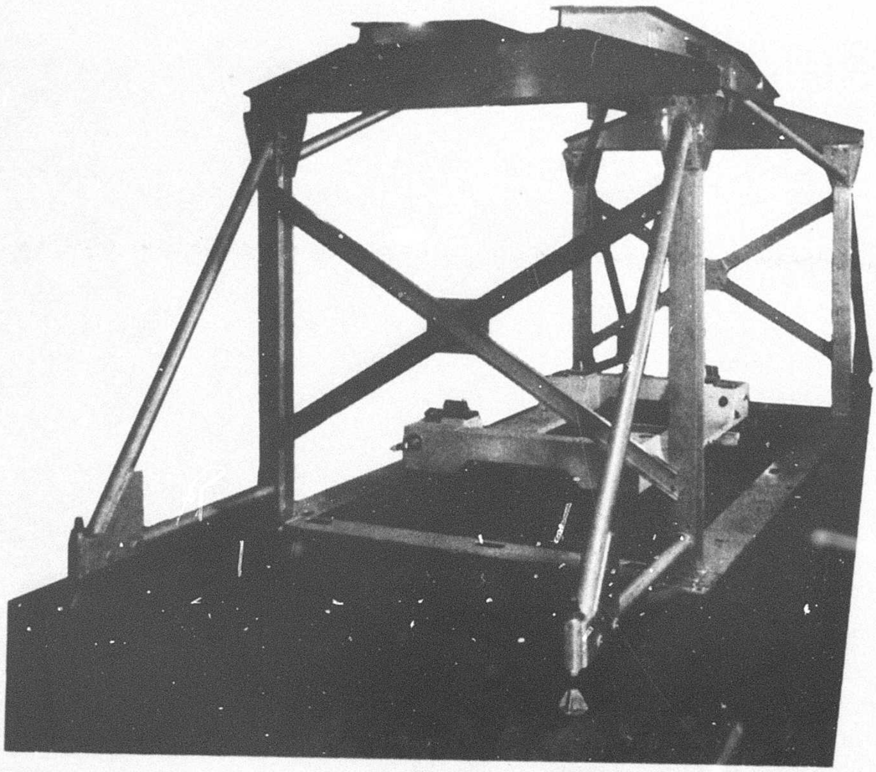

Figure 13
Loading Stand Assembly & Adapter Assembly

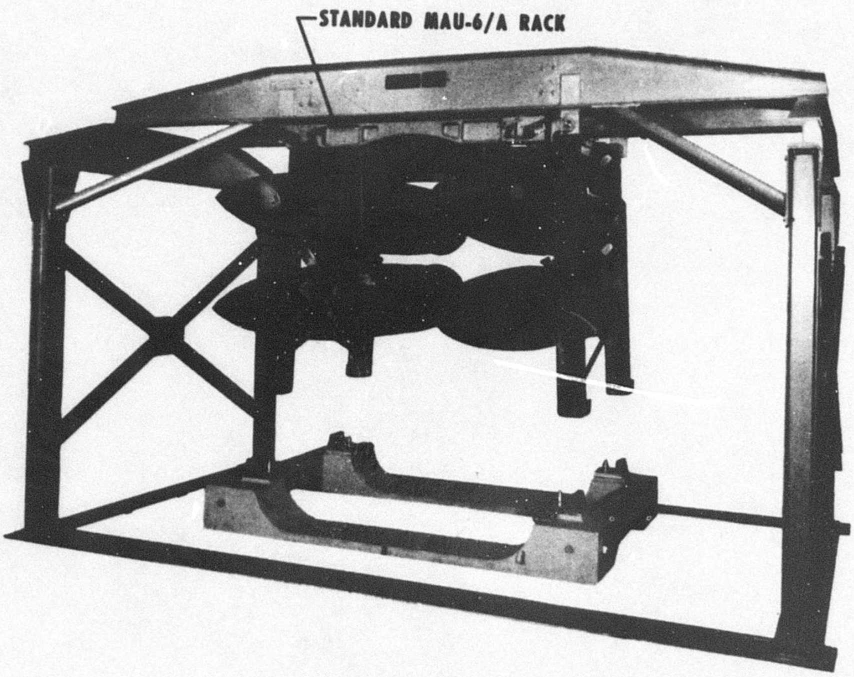

Figure 14
Clip-In & Handling Equipment With Dummy Stores

SECTION III

TABULATED DATA

Clip-In	
Height	58.32 in.
Width	47.50 in.
Length	77.25 in.
Weight	830 lbs w/o bomb racks or sway braces 2281 lbs w/9 sets bomb racks & sway braces
Capacity	
4 bombs	22- to 30-inch diameter maximum weight 4500 lbs each
6 bombs	20-inch diameter maximum weight 2500 lbs each
9 bombs	14- to 18-inch diameter maximum weight 2500 lbs each, center leg required
12 bombs	12-inch maximum diameter maximum weight 1200 lbs each no sway braces, center leg required
Weight of 2 center legs	142 lbs
Bomb Racks	
Weight	68 lbs w/o bumper spring (which are 2.3 lbs/pair)
Lug Centers	Both 14 and 30 inch
Capacity	4500 lb bomb at g loads of Spec MIL-A-8591 C
Sway Braces	
Weight	93 lbs w/o bumper springs (which are 2.3 lbs/pair)
Pad Centers	20.75 inch
Bomb Diameter	14- to 30-inch adjustable in 4 steps
Capacity	To match the bomb racks

Adapter

Height	15.25 in.
Width	61.00 in.
Length	107.00 in.
Weight	1275 lbs.
Capacity	20,000 lbs. (proof load 64,000 lbs)

Requires maximum width setting of MHU-7/M trailer.

Loading Stand

Height	106.00 in.
Width (including stabilizing jacks)	268 in.
Depth	99.25 in.
Inside Width	158 in.
Capacity	25,000 lbs. (proof load 32,000 lbs)
Weight	1182 lbs.

SECTION IV

DETAILED DESCRIPTION & DISCUSSION OF ITEMS

1. The clip-in body (Figure 1) is a hollow weldment fabricated mostly from 3/16 inch maraging steel (200 grade). Although this steel is quite expensive (approximately $3.00 per lb in small lots), it is well suited for this application. Design stress in the curved portion of the legs is as high as 138,400 psi (See Appendix). Ordinary steels quenched and tempered to take this stress will have an intolerable warpage. The maraging steel attained a hardness of approximate Rockwell "C" 52 with only a soaking treatment at 900° F. for 3 hours, after all machining was completed. Warpage was practically nil.

During load tests of the clip-in, the legs deflected outward about 4 inches (2-inch deflection per leg). This is the maximum that can be tolerated before interfering with the aircraft. (Interference will occur first at a point 20 inches above the bottom of the legs, at the longeron supporting the catwalk). A fit check in an aircraft disclosed that there is a space for a stiffener 2.5 inches wide on the sloping surface of the leg as shown in Figure 15. This stiffener plus increased thickness of metal, can be incorporated on future models, and should reduce the deflections by about 50 percent.

The present model of the clip-in was designed for four stores at 4500 lbs each (See Calculations, Appendix). These heavy stores were to allow for future weapon developments. Recently the trend has been to lighter weapons, so that 2500 lbs is a more realistic value. On this basis, either with or without the stiffener mentioned above, the deflection is not too serious a problem. Also it may be possible to change to

Structural steel with an initial yield of 100,000 psi and no heat treatment after fabrication.

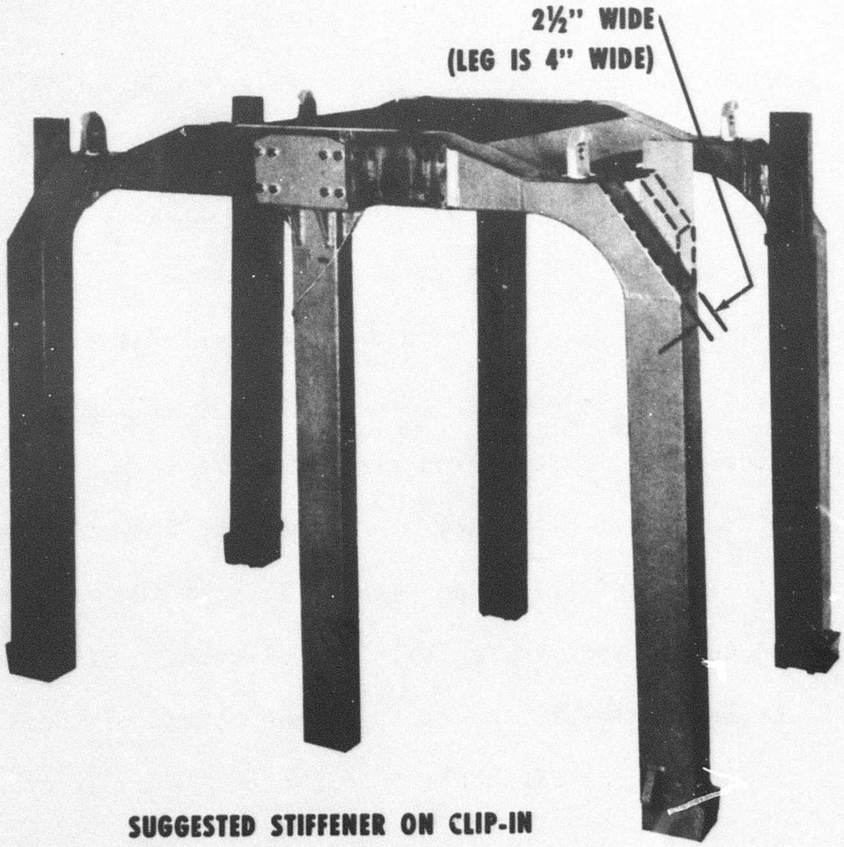

Figure 15
Suggested Stiffener on Clip-In

One component attached to the clip-in which was not supplied by Rock Island Arsenal is an electrical junction box. Space for this is available on the top surface in the center opening visible in Figure 1. The electrical cables from each bomb rack connect to this (refer to Figure 7), with only one cable (Drawing 65B3472) between the junction box and the aircraft.

Cross braces between the fore and aft legs have been provided (See Figure 4). The necessity of these will be determined by flight tests.

Since the bomb racks and sway braces can be pinned in various locations as required, the pin holes in the leg channels (See Figure 2) have been numbered starting from the top. The correct combinations for the various size bombs are shown on Drawing 65F3315.

This model of the clip-in has three optional positions of the center leg (See Figures 3 and 15). One of the side positions, the one used in Figure 3, (note "Forward" mark) interferes with the cable brackets on the MAU-6/A Rack, and should be eliminated.

For dimensions and construction details, refer to Drawing 65F3059.

2. The bomb racks (Figure 5 and Drawing 65F3328) are a modification of the MAU-12/A racks developed by the Air Force. The forced ejection feature was removed, the pivot trunnions added, the "bombs away" indicating switches relocated, the electrical connection and arming solenoid relocated, and interlocking slots for the sway braces added. Unchanged are the "over-center" feature of locking the release linkage, the use of propellant cartridges for operating the release linkage, and the safety interlocks and indicators.

The trunnions and bearings were designed for the 4500 lb bombs and the g loadings of MIL-A-8591 C. If the maximum weight is reduced to 2500 lbs, a lighter design is warranted.

When these racks are carrying bombs, the racks are pivoted away from the legs at about a 45° angle. After releasing its bomb, each rack except the upper ones, swings downward between the legs to clear the drop

path of the bombs above. A detent spring on each bearing block helps to hold the rack in this retracted position. To prevent the rack from momentarily swinging very far past this position, bumper springs were added later as shown on Drawing 65F3328. (Since 1095 spring steel was not on hand, grade 200 maraging steel was used).

3. The sway braces (Figure 6) are an unusual design in which the longer arms carrying the pressure pads that contact the bombs are adjustable for length. They are extended for the 30 inch diameter bombs, and shortened (total of 4 positions) for the small diameter bombs. A notch in these arms interlocks with the bomb rack, so that both the sway brace and bomb rack are free to retract as soon as the bomb is released.

Bumper springs similar to those for the bomb rack have been provided.

These sway braces are quite heavy (93 lbs each). With the reduction in weight of the bombs from 4500 lbs to 2500 lbs each, a large weight reduction can very easily be accomplished, probably to about 50 lbs.

In use, the sway brace pads should be torqued to some value (to be determined during vibration tests at Kirtland Air Force Base) that will assure contact against the bombs is maintained.

4. The loading adapter (See Figure 9) is the platform for supporting the clip-in during handling and transport by the MHU-7/M (or MHU-33/M) trailer. The pick-up points are shown in Figure 11. Two of the keying guide pins are 1.5 inches diameter, and the other two are 2 inches diameter so that the clip-in fits only one way. However, if desired, the plates holding these pins may be interchanged.

The two hold down clamps are for safety during transport.

The clip-in and adapter have a combined height of 70.57 inches, and were designed to go under the open bomb bay doors of the aircraft at 72 in. clearance. Reduction of this combined height is not recommended as the vertical clearance between bombs is as small as 0.7 inch on the 20 inch diameter stores (assuming the sway brace pads are perfectly adjusted) and the middle section of the adapter is as shallow as practicable.

Use of the adapter for cradling and carrying loose bombs is not intended due to the shall middle section.

As future bombs are now estimated to have a maximum weight of 2500 lbs each, an appreciable weight reduction could be effected on this adapter.

5. The loading stand (Figures 12, 13 and 14) is an aluminum alloy structure that may be dismantled to parts which are readily lifted by two men. The use of a hoist, lift truck, or scaffold is necessary for assembly and dismantling. All joints are numbered to avoid incorrect assembly.

When the MHU-7/M trailer is wheeled into place inside this loading stand, approximately 17 inch minimum working clearance is provided on each side.

The four stabilizing jacks on the ends provide the necessary sway rigidity. Without these, the weight of the clip-in and bomb load should not exceed 5,000 lbs.

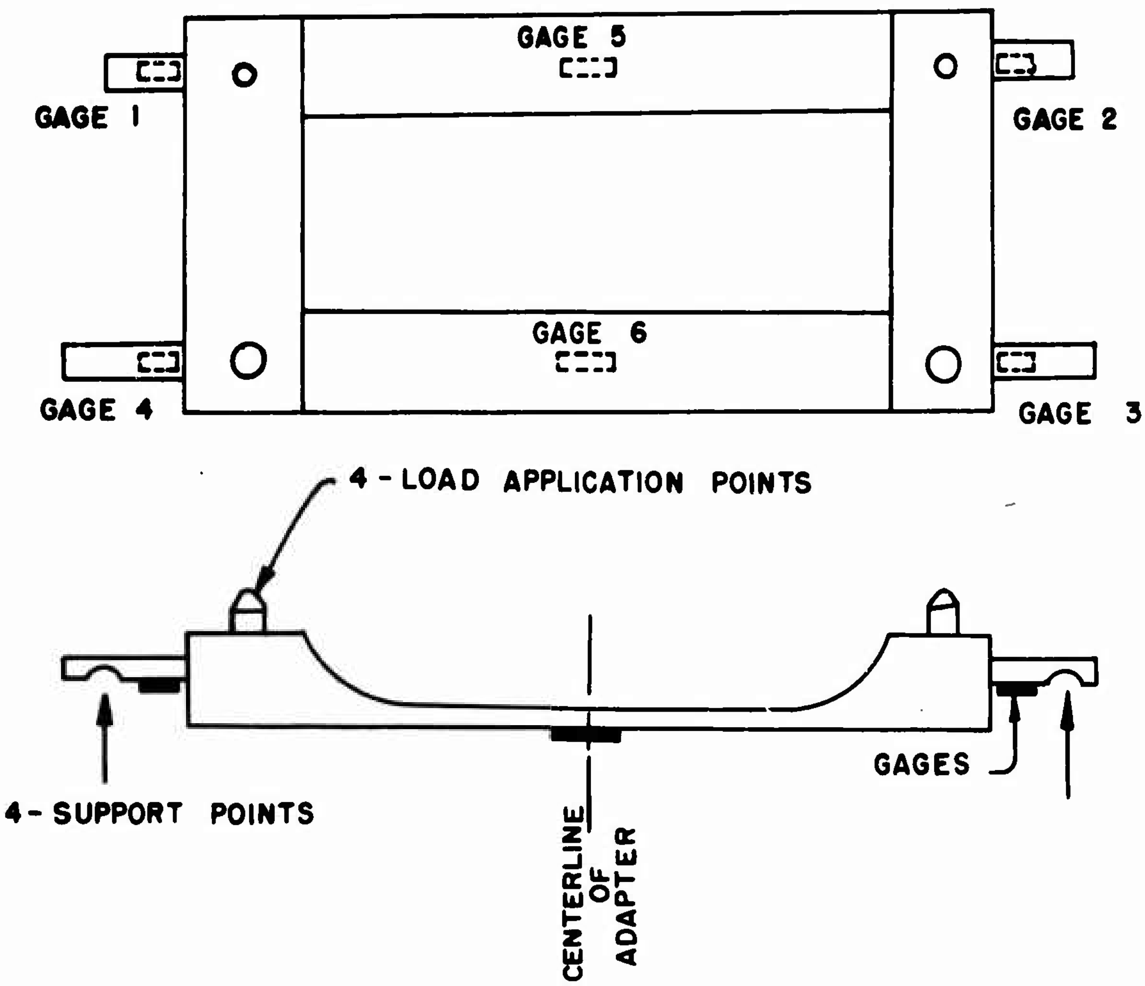

FIGURE 16

LOAD TEST OF ADAPTER ASSY

SECTION V

TESTS & RESULTS

1. Adapter Assembly (65F2900) (See Figure 9)

Strain gages were mounted on each of the retractable lifting arms and at the center of the long sides as shown in Figure 16. See Table I for Load Data.

TABLE I

LOAD TESTS ON ADAPTER ASSY. 65F2900

(See Figure 16)

Total Load lbs (sum of the 4 load points)	Gage #1		Gage #2		Gage #3		Gage #4		Gage #5		Gage #6	
	μ-in	psi	μ-in	psi	μ-in	psi	μ-in	psi	μ-in	psi	μ-in	psi
8,000	260		235		200		250		60		60	
12,000	400		360		340		390		80		100	
20,000	680		610		595		655		135		160	
24,000	820		740		740		805		160		195	
32,000	1120		1000		1000		1100		220		260	
40,000	1400		1250		1255		1370		275		325	
48,000	1690		1500		1520		1650		330		395	
52,000	1830		1630		1640		1790		355		420	
56,000	1970		1760		1760		1910		385		460	
60,000	2100		1890		1880		2040		410		485	
64,000	2250	67500	2010	60300	2030	60900	2190	65700	440	13200	520	15600

2. Loading Stand Assembly (66F3100) (See Figure 12)

Loads were applied vertically downward on each of the overhead cross beams, at the clip-in suspension points. Deflection and strain readings were recorded as follows:

TABLE II

Load per beam (lbs)	Avg Strain (micro-inches) at center of beam	Avg Stress (psi) at center of beam	Beam Deflection (inches)
2,000	115	1850	0.06
4,000	212	3400	
6,000	312	5000	
8,000	403	6500	
10,000	492	7900	0.44
12,000	580	9300	
14,000	665	10700	
* 16,000	745	12000	0.78

* This load of 16,000 lbs per beam represents 60 percent of the total safe load plus 1000 lbs(= 0.60 x 25000 + 1000 = 16,000 lbs).

3. Bomb Rack Assembly (65F3328)

a. As the two ejection cylinders were removed during conversion of the MAU-12/A rack to the design for this clip-in, bleed holes were drilled in the closing plug for the slave cylinder. This bled off so much gas that effective release was not obtained. Accordingly the holes were welded shut.

b. Locked-shut firing tests were conducted on each rack. The first rack was instrumented with strain gages on the gas tube for recording the pressure developed.

TABLE III

Test	Cartridge	Locked Shut Peak psi	Remarks
1	Two - ARD446-1	21750	Average time from ignition pulse to 10% peak pressure = 0.002 second
2	"	19400	
3	"	18500	Time from ignition pulse to 90% of peak pressure was 0.022 to 0.025 second
4	"	22500	

c. One dummy store (30 inch diameter) was loaded vertically thru its center of gravity to a total weight of 20,750 lbs. Then hydraulic pressure was applied to the cartridge cylinder, and gradually increased until release suddenly occurred at 16,500 psi.

d. As the release linkage had not been changed during our modification of the bomb rack, and future use will involve stores of considerably less weight, the bomb rack actuation was considered satisfactory.

4. Clip-In

a. The first test, which resulted in failure of a weld at the narrow upper section of one leg, where the channel extension begins, was made by inserting a hydraulic jack between the lower ends of a pair of legs formed by the inverted U structure. Strain gages were located approximately at positions 2 and 4 of Figure 17. The weld broke at 5800 lb load (25500 psi on the strain gage). The failure was repaired by chipping out this weld on each of the 4 legs, rewelding and then welding a 0.25 inch thick cover plate over this area. It is characteristic of the maraging steel used for the clip-in that this repair work plus a subsequent heat treatment the same as originally applied, resulted in such negligible warpage that straightening was not necessary.

b. The second test was preceded by a stress coat analysis of the critical areas (Figures 17 and 18) with the loads applied through a 30 inch diameter cylinder at an angle equal to the resultant of the vertical and horizontal g loadings used in the design calculations. Six strain gages were then mounted as indicated in Figure 18, which are areas of maximum strain as indicated by the stress coat.

c. The load test as shown in Figures 19 and 20 was then made, up to about 75 percent of the maximum loads used in the design calculations. These loads resulted in deflections which reached the clearance limit of our test stand structure and also which would result in interference inside the aircraft. The strain gage readings are given in Tables IV and V and the deflections in Table VI and Figure 21.

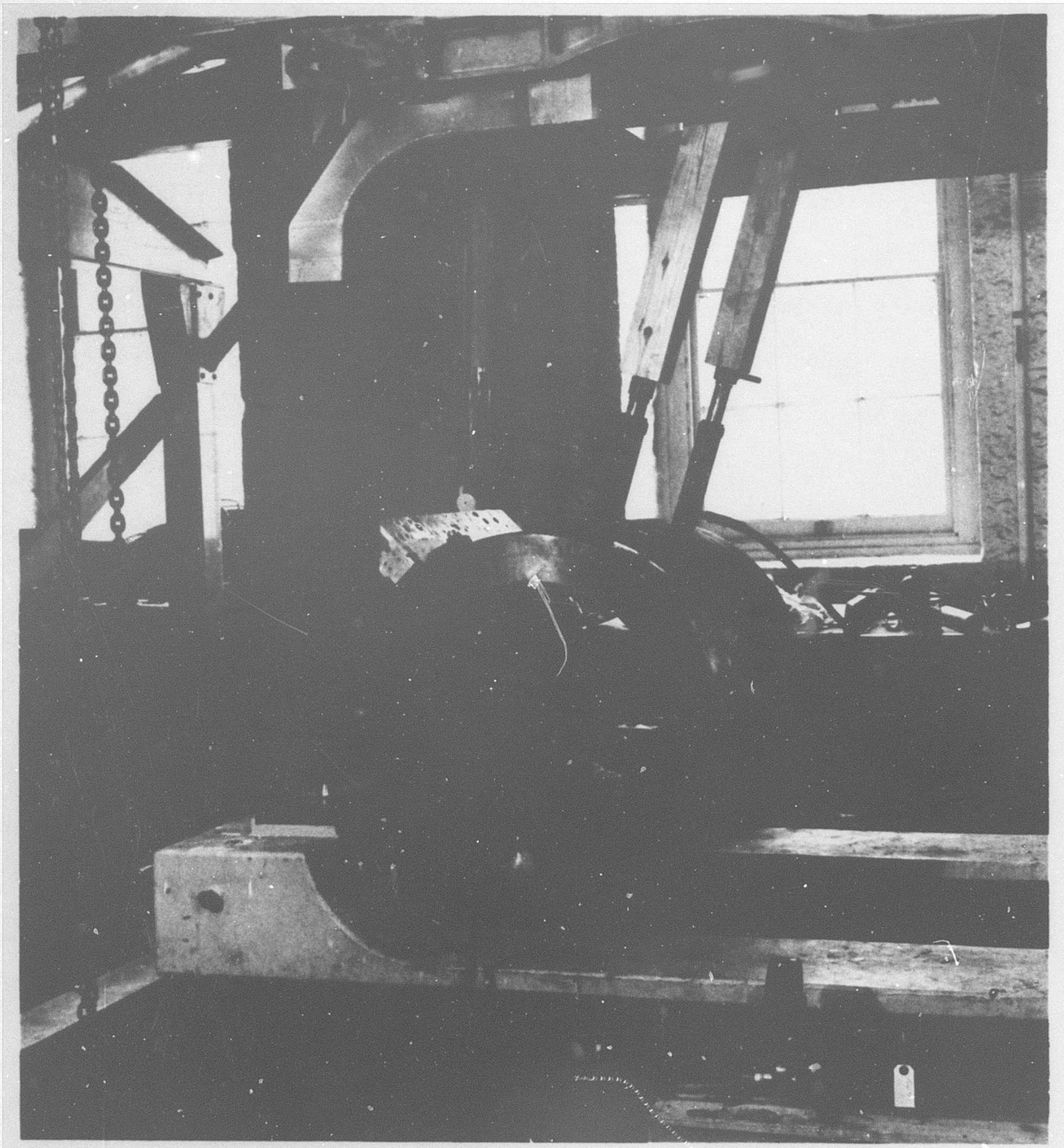

Figure 17
Stress-Coat Strain Test of Clip-In Frame

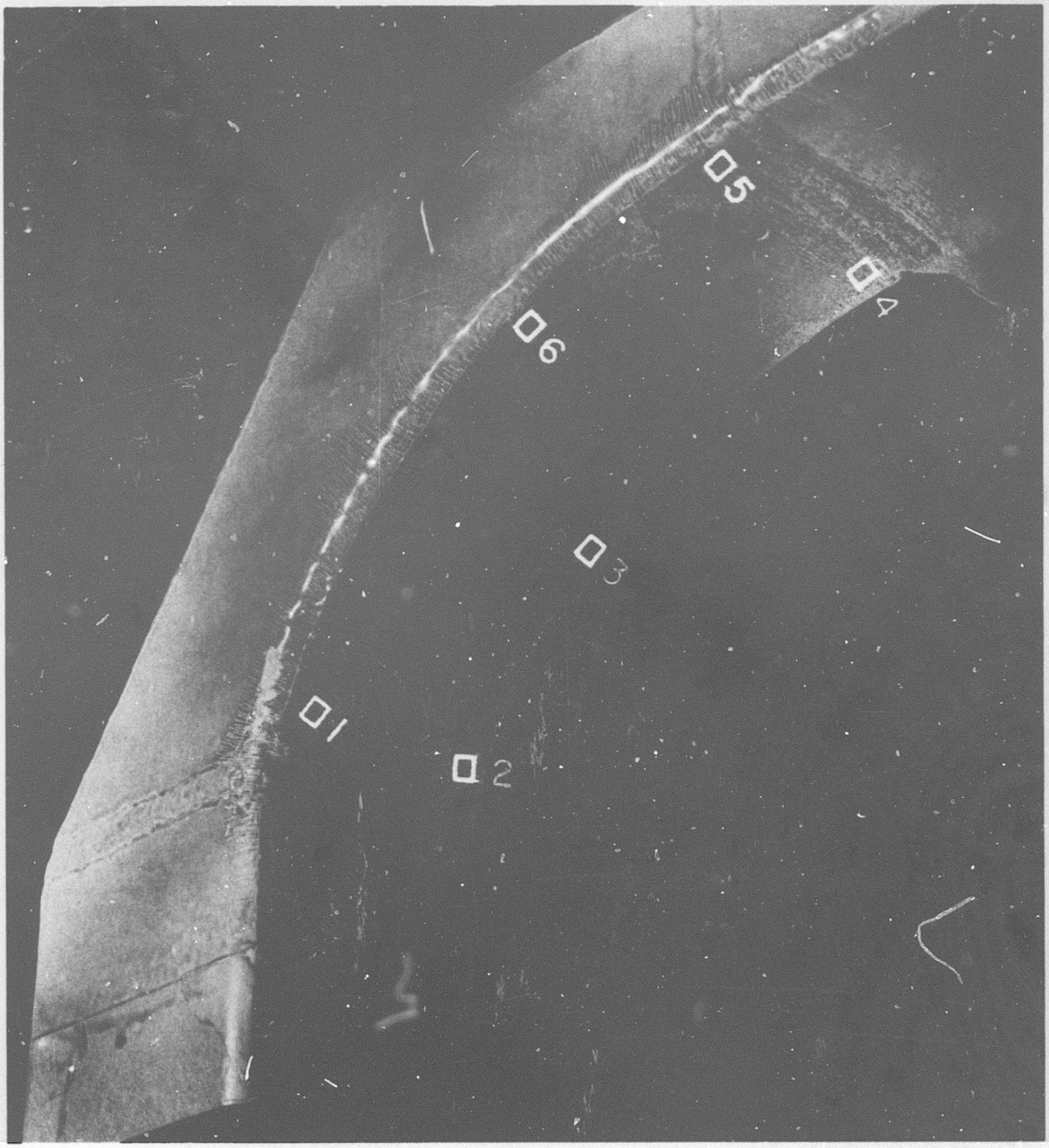

Figure 18
Stress-Coat Strains & Strain Gage Location
on Clip-In Frame

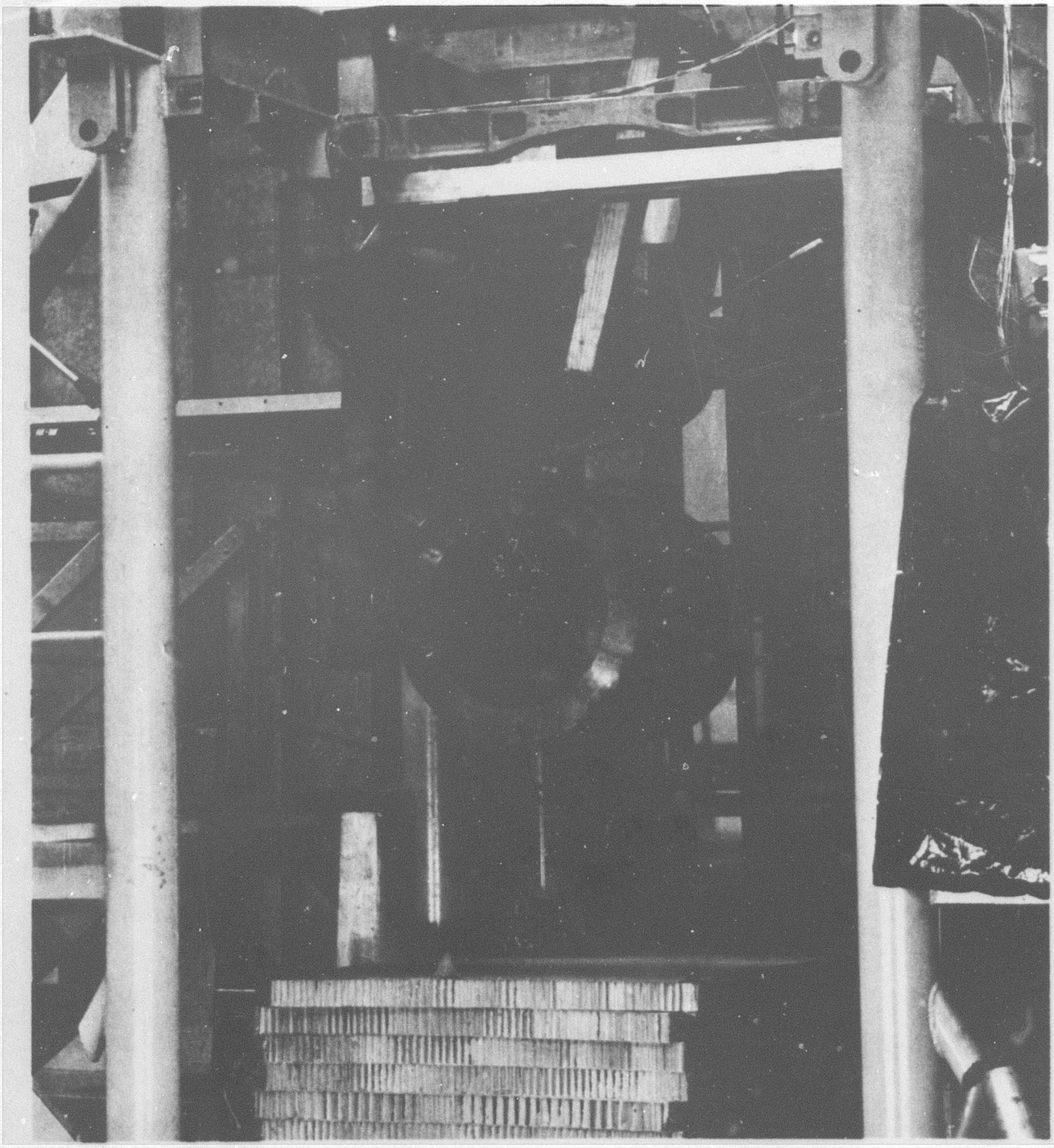

Figure 19
Maximum Load and Leg Deflection Test
of Clip-In

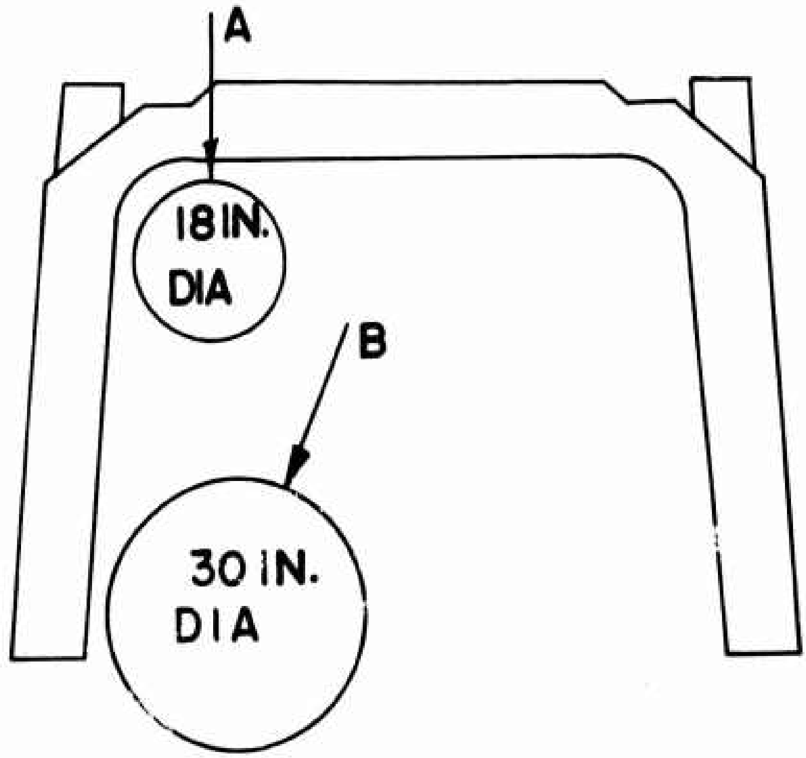

FIGURE 20

APPLICATION OF LOADS FOR
TEST OF CLIP-IN ASSY

TABLE IV

STRAIN GAGE DATA ON RIGHT FORWARD (OUTER) LEG (REFERENCE FIGURE 19)

	Load				Gage #1		Gage #2		Gage #3		Gage #4		Gage #5		Gage #6	
Store	Jack Load (lbs) (each)	Store Weight (lbs)	Total (lbs)	% of Max. Design Load	Strain μ-in	Stress psi	μ-in	psi	μ-in	psi	μ-in	psi	μ-in	psi	μ-in	psi
Upper	0	900	900		220		280		235		260		185		170	
Lower	0	1800	1800													
Upper	4100	900	9100	36	1555		1915		1725		1750		1410		1380	
Lower	4700	1800	11200													
Upper	5800	900	12500	48	2020	54500	2470	66700	2220	59900	2240	60500	1820	49100	1780	48100
Lower	6600	1800	15000													
Upper	6600	900	14100	54	2260	61000	2770	74700	2490	67200	2500	67500	2050	55300	2000	54000
Lower	7600	1800	17000													
Upper	7400	900	15700	60	2470	66700	3050	82300	2690	72600	2720	73400	2240	60500	2200	59400
Lower	8500	1800	18800													

Test continued at these loads as leg was deflecting to interfere with test stand. Stand has approximately the same clearance as the aircraft.

Interference removed for test of Table V.

TABLE V

STRAIN GAGE DATA ON LEFT FORWARD (OUTER) LEG

Store	Load			% of Max. Design Load	Gage #8		Gage #9		Gage #10		Gage #11	
	Jack Load (lbs) (each)	Store Weight (lbs)	Total (lbs)		Strain µ-in	Stress psi	Strain µ-in	Stress psi	Strain µ-in	Stress psi	Strain µ-in	Stress psi
Upper	4100	900	9100	36	1310		1570		1370		1480	
Lower	4700	1800	11200									
Upper	8200	900	17300	61	2230	60200	2650	71500	2320	62600	2540	68600
Lower	8500	1800	18800									
Upper	9000	900	18900	68	2510	67700	2950	79700	2550	68800	2820	76100
Lower	9500	1800	20800									
Upper	9900	900	20700	75	2760	74500	3250	87700	2840	76600	3140	84700
Lower	10400	1800	22600									

This side of test stand had more lateral clearance than the side used in Figure 19 and Table II. Gages 8 and 9 located approximately same as 4 and 5 of Figure 18. Gages 10 and 11 located approximately same as 1 and 2 of Figure 18. See Table IV and Figure 21 for deflection measurements on this leg.

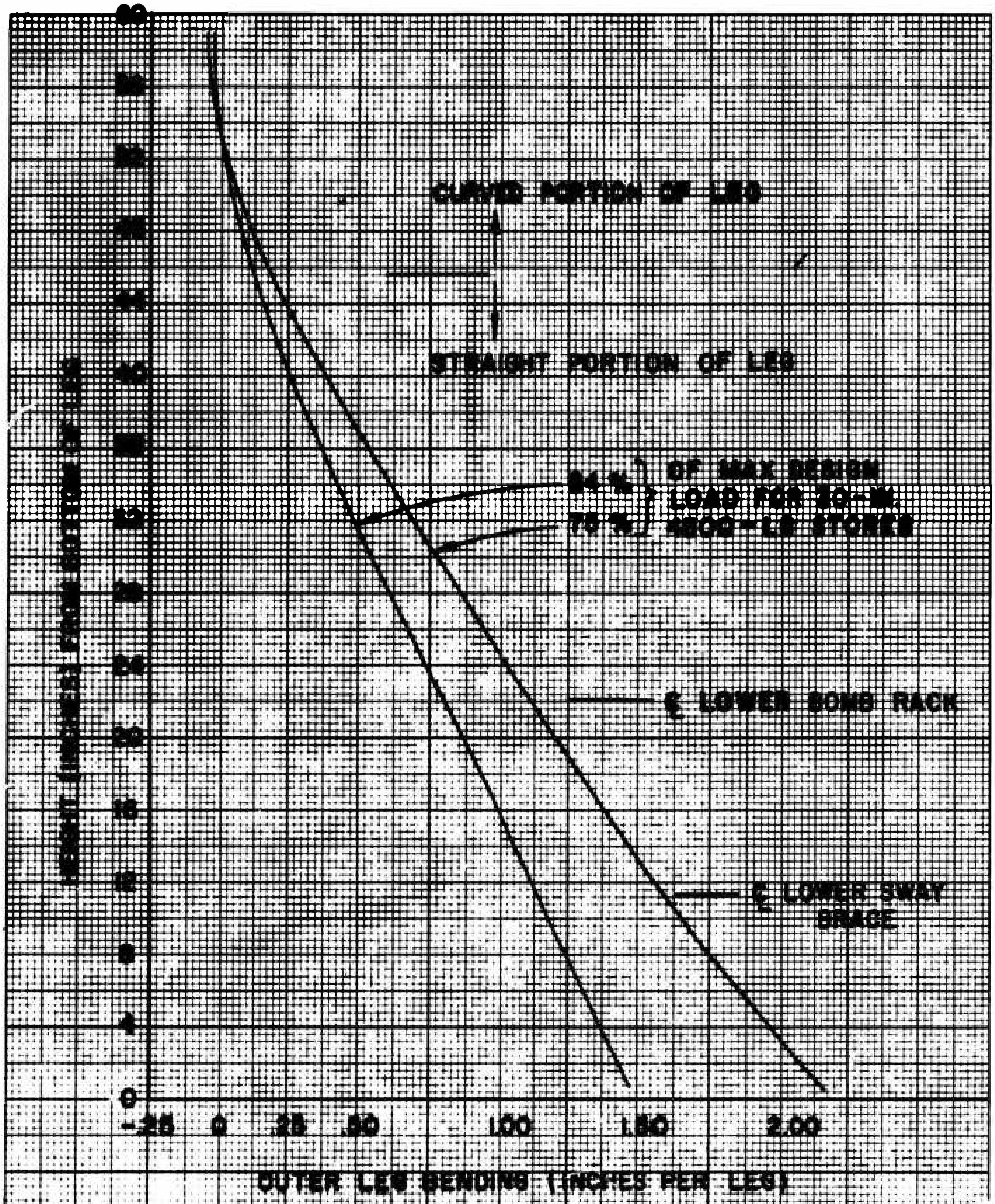

FIGURE 21

DEFLECTION TEST OF
OUTER LEG OF
UNIVERSAL CLIP-IN

TABLE VI

DEFLECTION OF LEFT FORWARD (OUTER) LEG (REFERENCE FIGURE 19)

Store	Load: Jack Load (lbs) (each)	Load: Store Weight (lbs)	Load: Total (lbs)	% of Max. Design Load	Deflection at Distance Above Bottom Surface of Leg (Inches): 1 Inch	8 Inch	16 Inch	24 Inch	32 Inch	46.75 In	57.50 In
Upper Lower	4100 4700	900 1800	9100 11200	36	29/32	23/32	19/32	15/32	5/16	1/16	0
Upper Lower	6600 7600	900 1800	14100 17000	54	1-7/16	1-7/32	31/32	23/32	1/2	3/32	1/32
Upper Lower	8200 8500	900 1800	17300 18800	61	1-5/8	1-5/16	1-1/32	13/16	17/32	1/8	1/32
Upper Lower	9000 9500	900 1800	18900 20800	68	1-7/8	1-9/16	1-1/4	15/16	5/8	5/32	1/16
Upper Lower	9900 10400	900 1800	20700 22600	75	2-1/8	1-3/4	1-3/8	1	11/16	5/32	

Deflections for the 54% and 75% loads are plotted in Figure 21.

d. Similar tests on the removable center leg are given in Table VII and the deflections in Table VIII and Figure 22.

e. Notes on loading used in strain gage test follows:

Load B was applied by a pair of hydraulic jacks at approximately a 15 degree angle. This angle comes from the resultant of 5.39 g vertical load and 1.5 g horizontal load.

Load A was also applied by a pair of hydraulic jacks, but in a vertical direction due to available clearance thru the top of the clip-in. Neglecting the horizontal component in this case had a minor effect on the stresses as its moment arm was relatively short.

For 100 percent loads as used in the design calculations, the g loadings were further increased by a factor of 1.2. This allows for the 60 to 40 percent division of the c.g. of the store being closer to one leg of the clip-in.

The load tests of the outer legs were made using the two dummy stores with each loaded about equally. The design calculations showed that two 4500-lb stores mounted on the outside legs produced the maximum stresses, making the estimation of percent of Maximum Design Stress a simple ratio of loads. However, three 2000-lb stores mounted on the center removable leg produced the maximum stresses. Since only two stores were used in these tests, the estimation of the percent of maximum design load for the center leg under the various test loadings is as follows:

From Appendix I, Calculations, paragraph I, page 51, stores numbers 4, 5, and 6 have a total bending moment of 859,000 inch lbs, all the moments being positive in this case. The moment is distributed 60

to 40 percent, so that one leg is subjected to 515,400 inch-lbs bending moment.

TABLE VII

STRAIN GAGE DATA ON CENTER LEG (FIGURE 2, 3, & 4)

Store	Load: Jack Load (lbs) (each)	Load: Store Weight (lbs)	Load: Total (lbs)	% of Max. Design Load	Gage #1 Strain μ-in	Gage #1 Stress psi	Gage #2 Strain μ-in	Gage #2 Stress psi	Gage #3 Strain μ-in	Gage #3 Stress psi	Gage #4 Strain μ-in	Gage #4 Stress psi
Upper	0	900	900		-150		130		70		-155	
Lower	0	1800	1800									
Upper	4500	900	9900	44	-650	-17500	810	21900	720	19500	-675	-18200
Lower	4700	1800	11200									
Upper	4500	900	9900	55	-820	-22100	1040	28100	950	25600	-845	-22800
Lower	6600	1800	15000									
Upper	4500	900	9900	66	-1000	-27000	1280	34500	1180	31900	-1005	-27100
Lower	8500	1800	18800									
Upper	4500	900	9900	71	-1070	-28900	1370	37000	1310	35400	-1075	-29000
Lower	9400	1800	20600									

Gage 1 and 2 located on ribs of front leg.
Gages 3 and 4 located on ribs of rear leg.
Applied load directions same as for outer leg.
Negative values indicate compressive stress.

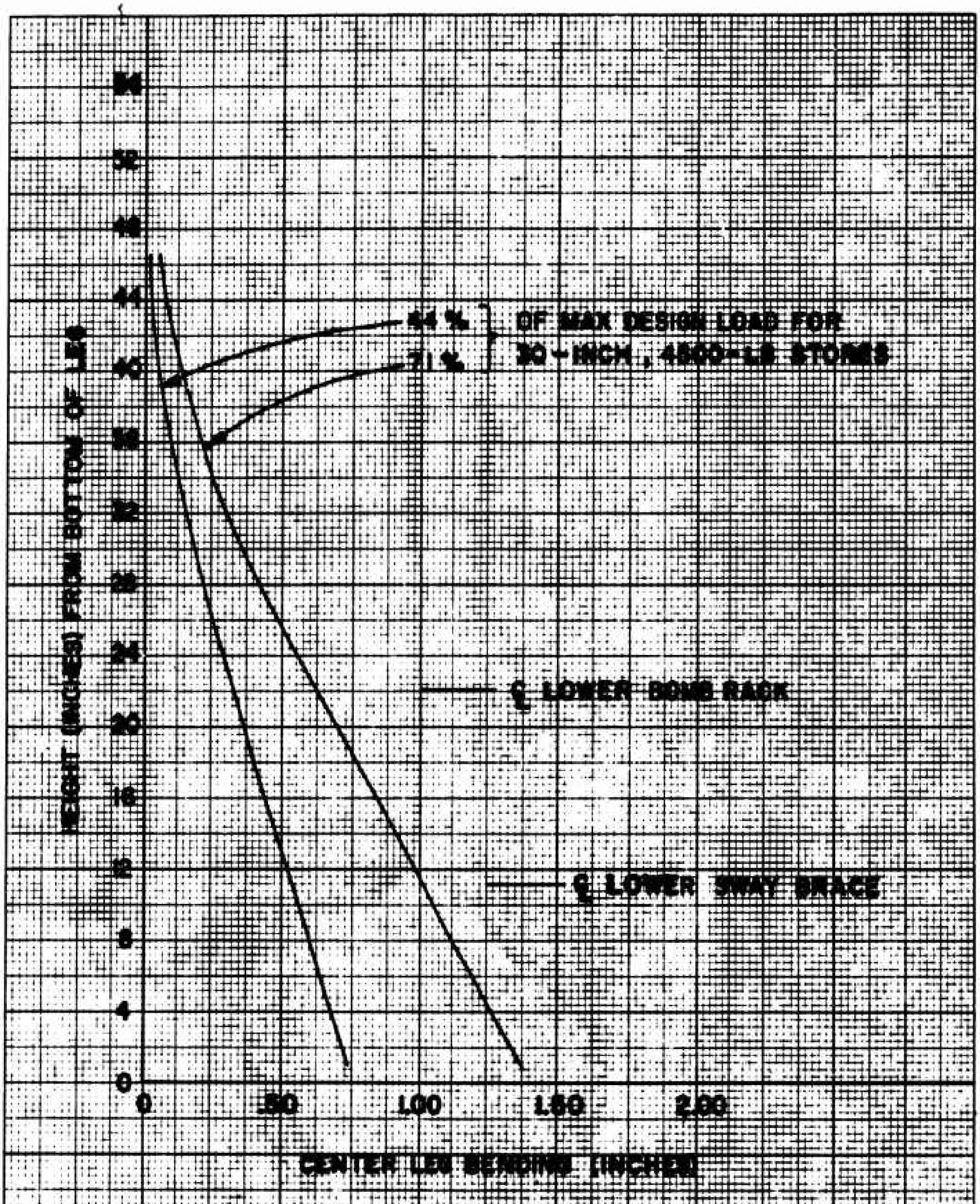

FIGURE 22
DEFLECTION TEST OF
CENTER LEG OF
UNIVERSAL CLIP-IN

NO. 340-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH
EUGENE DIETZGEN CO.
MADE IN U. S. A.

TABLE VIII

DEFLECTION OF CENTER LEG (REFERENCE FIGURE 19)

Store	Jack Load (lbs) (each	Store Weight (lbs)	Total (lbs)	% of Max. Design Load	Deflections at Distance Above Bottom of Leg						
					1 In.	8 In.	16 In.	24 In.	32 In.	36 In.	46.25 In.
Upper Lower	0 0	900 1800	900 1800		3/64	1/16	15/32	6/32	1/64	1/64	0
Upper Lower	4500 4700	900 1800	9900 11200	44	47/64	19/32	29/64	19/64	6/32	7/64	1/32
Upper Lower	4500 6600	900 1800	9900 15000	55	NOT RECORDED						
Upper Lower	4500 8500	900 1800	9900 18800	66	1-15/64	1-1/64	49/64	1/2	9/32	19/32	3/64
Upper Lower	4500 9400	900 1800	9900 20600	71	1-23/64	1-1/8	53/64	35/64	5/16	7/32	1/16

Deflections for the 44% and 71% Loads are plotted in Figure 22.

Resonant Frequency Tests

With the 30-inch diameter dummy store (1750 lbs weight) in the lower position on the outer legs (no other stores, racks or sway braces) resonance was at 21.4 cycles per second.

The above frequencies were determined by recording the output from a strain gage, position 1, Figure 18, with the resonant vibration initiated manually. Secondary frequencies were quite low.

A similar test on the center leg, with an 18-inch 900 lb store in the extreme upper position, and a 30-inch 1750 lb store in the lower position, resonance was 6.0 cycles per second.

SECTION VI

OPERATING RECOMMENDATIONS

The system is designed for use as follows:

The clip-in, either empty or loaded to its capacity, may be placed on the loading adapter and transported by the MHU-33/M trailer. This combination will go under the bomb bay of the B52 aircraft with approximately 1 inch clearance.

To load the stores, the clip-in must be suspended from the Loading Stand (65F3100) with a MAU-6A rack as the supporting member. The quantity and location of the bomb racks and sway braces vary with the size of the stores, according to the table on Drawing 65F3315. Also shown in this drawing are the electrical cables for each store. It is intended that SAC inventory handling equipment be utilized for transporting and loading the individual stores into the clip-in. stores into the clip-in.

The bomb racks are operated the same as the MAU-12/A racks, and therefore the instructions for their use need not be repeated here. The major differences are:

1. The ejection cylinders were removed.

2. The gas lines were sealed adjacent to the orifices for the ejection cylinders.

3. The method of mounting the racks in the clip-in uses trunnions and bearings which permit them to retract from the drop path of the stores above.

The sway braces are adjustable to four lengths. The proper length for each store diameter is also given on Drawing 65F3315.

The pads will require a predetermined torque in tightening, probably variable with the weight of the store, which has not been specified due to the limited testing by Rock Island Arsenal. Each sway brace should be interlocked with its respective bomb rack as the store is brought into position and latched into the bomb rack hooks. To a limited extent, the nominal spacing between adjacent stores is adjustable by the sway brace pads.

During loading tests at Kirtland Air Force Base, it was pointed out by the loading crews that they are required to visibly check, from the ground, that the clip-in is securely latched into the aircraft. This requirement was new to the design personnel. On the present clip-in, the stores completely obscure the latching area, making such a visible check impractical. No quick and easily applied modification to correct this is apparent at this time.

SECTION VII

CONCLUSIONS & RECOMMENDATIONS

The design of the items furnished under this contract has quite closely followed the criteria set forth in the MIPR, the layouts furnished by the Project Officer at Kirtland Air Force Base, and the verbal suggestions submitted intermittently. The system has been fit checked in a B52 aircraft and several flight drop tests made. Functioning has been satisfactory.

The outstanding features which have been demonstrated by this clip-in include:

1. The increased capacity possible with the inverted "U" design.

2. The adaptability of one clip-in design to accommodate a wide range of store sizes and quantities. This will have a marked effect on minimizing the number of items to be carried in the equipment inventory.

3. The loading and handling equipment will require only two new items — a loading stand and an adapter for transporting the clip-in on the trailer.

4. The small amount of warpage and the high strength obtained in maraging steel.

Subsequent to modification of the first eight bomb racks, Rock Island Arsenal was informally requested to consider other means besides cartridges for actuating the bomb racks. Previous tests had required a hydraulic pressure of 16,500 psi on a piston diameter of 0.610 inch, with a powered stroke of about 0.06 inch. This represents approximately 400 inch lbs of energy. To obtain this, a solenoid weighing

about 20 lbs would be required, plus a toggle arrangement to operate the over-center release system of the bomb rack.

Also discarded were several stored energy schemes because of the inherent danger of accidental release. An electrical a.c. linear motor (similar to a solenoid with multiple coils and a long plunger) also could not furnish sufficient energy even on a 1-second intermittent rating. Since a pneumatic or hydraulic system is incompatible with the power available to the clip-in, no alternate method of activation appears practical. All this indicates that a fully contained propellant cartridge* is probably the best method.

* The "Telecartridge" produced by Aircraft Armament, Inc. Cockeysville, Maryland.

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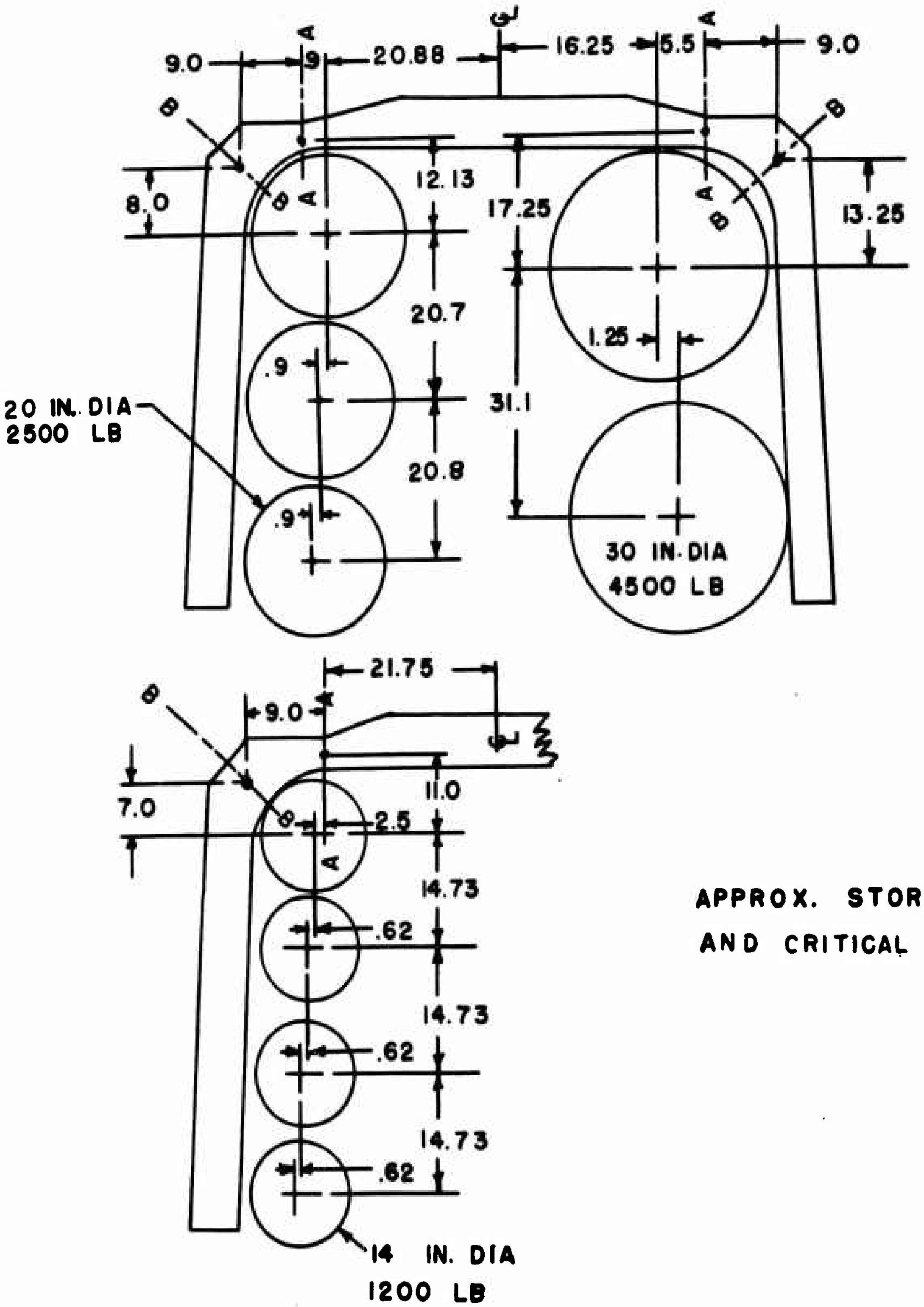
Preliminary Operating Instructions Pertaining to Experimental Clip-In and Equipment (Four Stores Free Fall), R&E Division, Rock Island Arsenal, April 1964, Unclassified.

Lorimor, G.O., Final Report, Four Weapon Free Fall, Advanced Clip-In and Equipment, Report No. 64-1631, R&E Division, Rock Island Arsenal, May 1964, Unclassified.

APPENDIX

UNIVERSAL CLIP-IN CALCULATIONS

1. Stores Position



APPROX. STORES LOCATION AND CRITICAL SECTIONS

II. Loads - per MIL-A-8591-C, for Fuselage Mounted Stores

Sideways (n_y)	± 1 G ± 1.5 G	(over 3500 lbs) (over 3500 lbs & less)
Vertical - up ($+n_z$)	2 G 3 G	(over 3500 lbs) (3500 lbs & less)
Vertical - down ($+n_z$)	5 G 7.5 G	(over 3500 lbs) (3500 lbs & less)
Fore & Aft (n_x)	± 1.5 G ± 2 G	(over 3500 lbs) (3500 lbs & less)
Pitching ( )	± 2.5 Rad/Sec^2 ± 6 Rad/Sec^2	(over 3500 lbs) (3500 lbs & less)

III. Est. Effect of Pitching Accleration

Torque = $I\ddot{\theta}$ Where I is assumed as follows:

Length	Diam	Weight	I(Slug-Ft^2)
91.1	18.2	1200	80
116.8	23.3	2297	276
146.0	30	4500	1800

For 4500 lb Store

Torque = (1800)(2.5) = 4500 ft-lbs.

Lug Reaction for 30 inch centers = $\frac{4500}{2.5}$

= 1800 lbs Vertical

= 0.40 G to be added to $\pm n_z$

For 2500 lb Store (Est. I = 300)

Torque = (300)(6) = 1800 ft-lbs

Lug Reaction for 30 inch centers = $\frac{1800}{2.5}$

= 720 lbs Vertical

= 0.29 G to be added to $\pm n_z$

For 1200 lb Store

Torque = (80) (6) = 480 ft-lbs.

Lug Reaction for 14 inch centers = $\frac{480}{14\text{-}1/2}$

= 420 lbs Vertical
= 0.34 G to be added to $\pm n_z$

IV. Bending Moment at Section A-A

For 30 Inch Diameter Stores

Upper Store -	Side Load	=	(4500) (1) (17.25)	=	77600
	Vert Load	=	(4500) (5.40) (5.5)	=	133700
Lower Store -	Side Load	=	(4500) (1) (48.35)	=	217600
	Vert Load	=	(4500) (5.40) (4.25)	=	103300
Total for front and rear legs					532200

Assume C.G. of store is off-center so one leg carries 60% of load.

Bending Moment = (.6) (532,200) = 319,300 in-lbs.

For 20 Inch Diameter Stores

Upper Store -	Side Load	=	(2500) (1.5) (12.1)	=	45400
	Vert Load	=	(2500) (7.79) (.88)	=	17100
Middle Stores	Side Load	=	(2500) (1.5) (32.83)	=	123100
	Vert Load	=	(2500) (7.79) (0.00)	=	0
Lower Stores -	Side Load	=	(2500) (1.5) (53.63)	=	201100
	Vert Load	=	(2500) (7.79) (.88)	=	-17100
					369600

Assume C.G. of store is off-center so one leg carries 60% of load.

Bending Moment = .6(369600) = 221,800 in. lbs.

For 14 Inch Diameter Stores

Upper Store -	Side Load	=	(1200) (1.5) (11.00)	=	19800
	Vert Load	=	(1200)(7.5 + .34)(2.50)	=	23500
#2 Store	Side Load	=	(1200)(1.5) (25.73)	=	46300
	Vert Load	=	(1200)(7.5 + .34)(3.12)	=	29400
#3 Store	Side Load	=	(1200)(1.5) (40.47)	=	72800
	Vert Load	=	(1200)(7.5 + .34)(3.75)	=	35300
Lower Store -	Side Load	=	(1200)(1.5) (55.20)	=	99400
	Vert Load	=	(1200)(7.5 + .34)(4.38)	=	41200
Total for front and rear legs					367700

Assume C.G. of store is off-center so one leg carries 60% of load.

Bending Moment = .6(367700) = 220,600 in-lbs.

V. Bending Moment at Section B-B

Section B-B falls between the attaching points for the upper store, but the error introduced by overlooking this will be quite small.

For 30 Inch Diameter Stores

Upper Stores -	Side Load	=	(4500) (1) (13.25)	=	59600
	Vert Load	=	(4500) (5 + .40) (14.35)	=	353600
Lower Stores -	Side Load	=	(4500) (1) (44.33)	=	199500
	Vert Load	=	(4500) (5 + .40) (13.30)	=	323200
Total for front and rear legs					935900

Assume C.G. of store is off-center so one leg carries 60% of load.

Bending Moment = 561,500 in-lbs.

For 20 Inch Diameter Stores

Upper Stores -	Side Load	=	(2500) (1.5) (8.0)	=	30000
	Vert Load	=	(2500)(7.5 + .29)(9.89)	=	192600
Middle Stores -	Side Load	=	(2500)(1.5)(28.7)	=	107600
	Vert Load	=	(2500)(7.5 + .29)(9.0)	=	175300
Lower Stores -	Side Load	=	(2500)(1.5)(49.4)	=	185300
	Vert Load	=	(2500)(7.5 + .29)(8.12)	=	158100
Total for front and rear legs					848900

Assume 60% of load carried on one leg

Bending Moment - 509300 in-lbs.

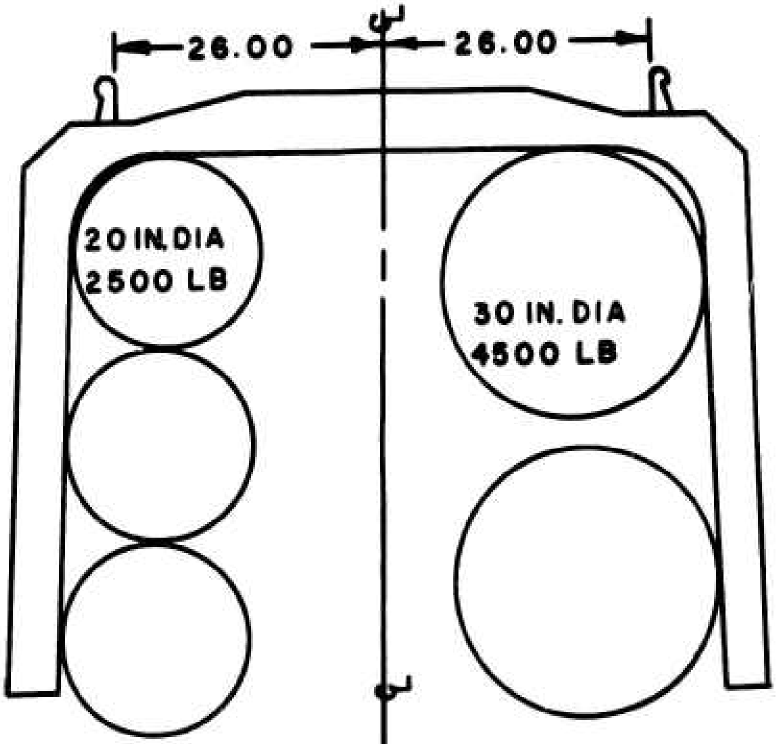
For 14 Inch Diameter Stores

Upper Stores -	Side Load	=	(1200)(1.5)(7.0)	=	12600
	Vert Load	=	(1200)(7.5 + .34)(6.75)	=	63500
#2 Stores	Side Load	=	(1200)(1.5)(21.73)	=	39100
	Vert Load	=	(1200)(7.5 + .34)(6.12)	=	57600
#3 Stores	Side Load	=	(1200)(1.5)(36.46)	=	65600
	Vert Load	=	(1200)(7.5 + .34)(5.50)	=	51700
Lower Stores -	Side Load	=	(1200)(1.5)(51.19)	=	92100
	Vert Load	=	(1200)(7.5 + .34)(4.88)	=	45900
Total for front and rear legs					428100

Assume C.G. of store is off-center so one leg carries 60% of load.

Bending Moment = 256900 in-lbs.

VI. Loads - On Hooks



For 30 Inch Diameter Stores

Two Stores - Side Load	= (2) (4500) (1)	=	9000
Vert Load	= (2) (4500) (5.40)	=	48600

Assume C.G. of store is off-center so one hook carries 60% of load.

Side Load	= (.6) (9000)	=	5400
Vert Load	= (.6) (48600)	=	29200

For 20 Inch Diameter Stores

Three Stores - Side Load	= 3(2500) (1.5)	=	11250
Vert Load	= 3(2500) (7.79)	=	58425

Assume C.G. of store is off-center so one hook carries 60% of load.

Side Load	= (.6) (11250)	=	6750
Vert Load	= (.6) (58425)	=	35055

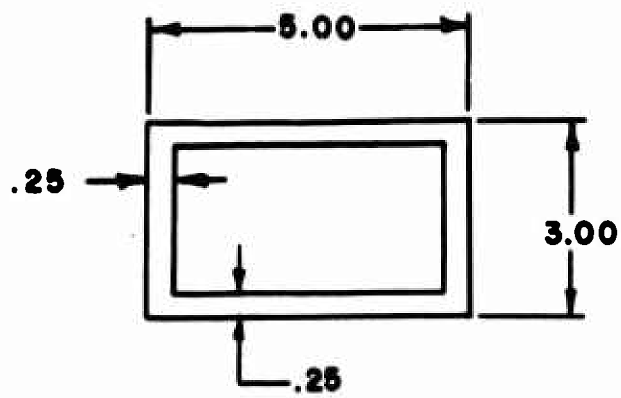
For 18 Inch Diameter Stores

4.5 Stores - Side Load	=	4.5 (2000) (1.5)	=	13500
Vert Load	=	4.5 (2000) (7.79)	=	70110

Assume C.G. of store is off-center so one hook carries 60% of load.

Side Load	=	.6 (13500)	=	8100
Vert Load	=	.6 (70110)	=	42066

VII. Stress at Section A-A



$I = (BH^3 - bh^3)/12 = (5)(3)^3 = (4.50)(2.50)^3 / 12$

$= 135 - 70.31 / 12 = 5.38$

M = Bending Moment of 30 inch diameter stores

- Bending Moment of load on hooks

= 319,300 + (5400 + 2500)(4.8)-(29200 +2500(5.4) (4.45)

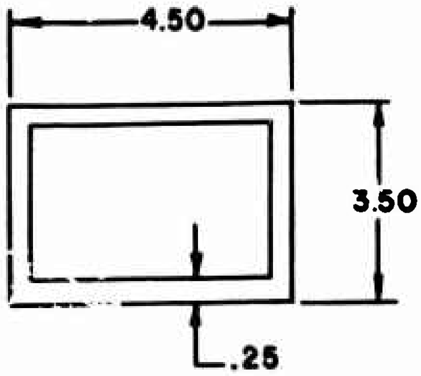
= 319300 + 37900 - 190,000

= 167200

Stress at A-A $= \frac{MC}{I} = (167200)(1.5) / 5.38$

= 46,600 PSI

VIII. Stress at Section B-B



$I = (BH^3 - bh^3)/12$

$I = (4.5)(3.5)^3/12 - (4.0)(3.0)^3/12$

$I = (192.94\ 0\ 108)/12 - 84.94/12$

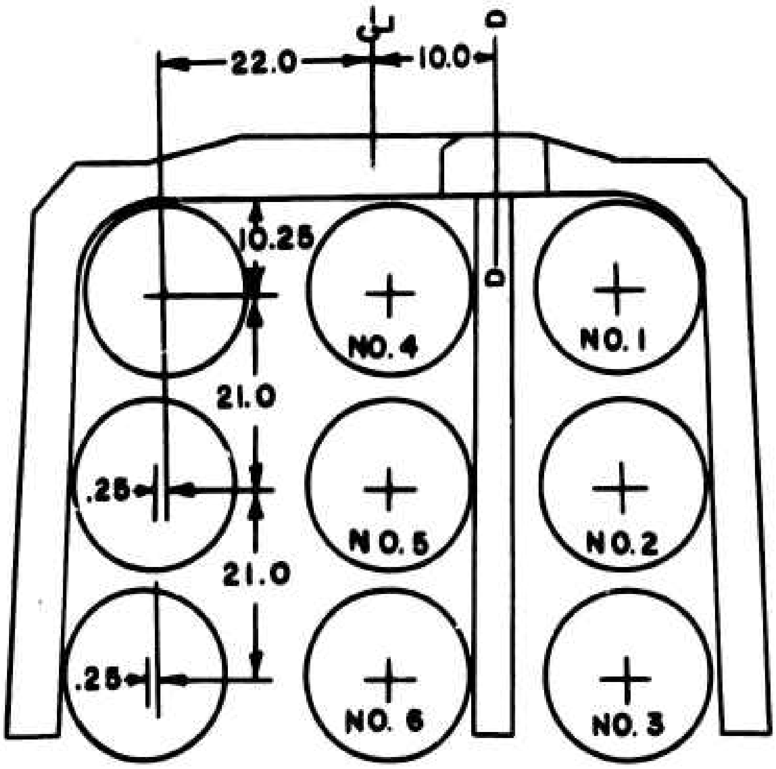
$I = 7.1$

Stress at Section B-B $= \frac{MC}{I}$

$S = (561500)(1.75)/7.1$

$S = \underline{138,400\ PSI}$

IX. Removable Leg Position



18 IN. DIA STORES LOCATION

The critical condition for the removable leg is when loaded with three 18 inch diameter stores as shown above.

Also, this is the critical condition for the top part of the framework. The removable leg may also be positioned on the centerline of the clip-in. However, this position does not provide any maximum loadings.

X. Bending Moment at Section D-D for 18 Inch Diameter Stores

No. 1 Store -	Side Load =	(2000)(1.5)(13.4)	=	40200
	Vert Load =	(2000)(7.79)(12.0)	=	187000
No. 2 Store -	Side Load =	(2000)(1.5)(34.4)	=	103200
	Vert Load =	(2000)(7.79)(12.25)	=	190900
No. 3 Store -	Side Load =	(2000)(1.5)(55.40)	=	166200
	Vert Load =	(2000)(7.79)(12.50)	=	194800
No. 4 Store -	Side Load =	(2000)(1.5)(13.4)	=	40200
	Vert Load =	(2000)(7.79)(11.75)	=	183100
No. 5 Store -	Side Load =	(2000)(1.5)(34.4)	=	103200
	Vert Load =	(2000)(7.79)(11.75)	=	183100
No. 6 Store -	Side Load =	(2000)(1.5)(55.4)	=	166200
	Vert Load =	(2000)(7.79)(11.75)	=	183100
TOTAL LOAD				642600

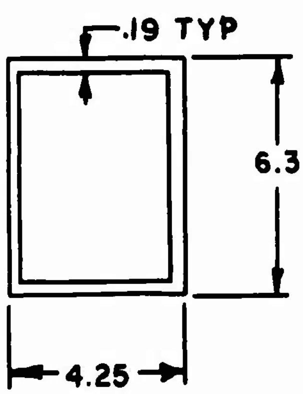
Assume C.G. of store is off center so one leg carries 60% of load.

Bending Moment = 385600

Bending Moment at Section D-D for hook loads resulting from nine 18 inch stores

Hook -	Side Load =	(8100) + 250 (1.5)	(3.15)	=	26700
	Vert Load =	(42066) + 250 (7.79)	(16)	=	-704200

Resultant Bending Moment on Section D-D 292000



$I = (BH^3 - bh^3)/12 = (4.25)(6.3)^3 - 3.88(5.93)^3/12$

$I = (1063 - 809)/12$

$I = 21.1$

XI. Stress at Section D-D = $(MC)/I = (292000)(3.15)/21.1$

= 43600 PSI

XII. Approximate Leg Deflections

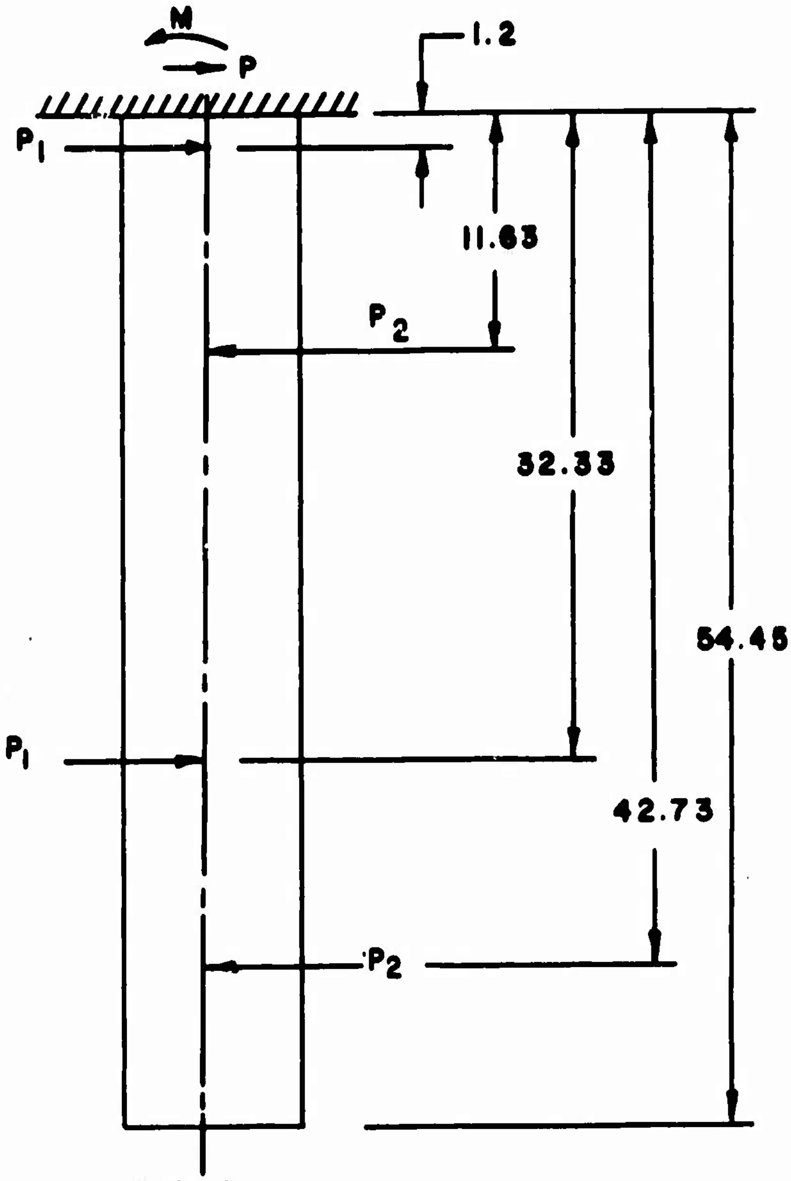


FIG A

An approximation of the deflections of the legs can be made by approximating the leg configuration of 65F3059 by that of Fig. A.

Deflection of Leg (Formula)

$$\left.\begin{aligned}
EI\frac{d^2v}{dx^2} &= -M + PX \\
EI\frac{dy}{dx} &= -MX + \frac{PX^2}{2} + C_1 \\
EIY &= \frac{-MX^2}{2} + \frac{PX^3}{6} + C_1X + C_2
\end{aligned}\right]\ 0 < X < 1.2$$

$$\text{AT } X = 0,\ Y = 0,\ \frac{dy}{dx} = 0,\quad \therefore C_1 = C_2 = 0$$

$$\left.\begin{aligned}
EI\frac{d^2y}{dx^2} &= -M + PX + P_1(X - 1.2) \\
EI\frac{dy}{dx} &= -MX + \frac{PX^2}{2} + \frac{P_1(X - 1.2)^2}{2} + C_3 \\
EIY &= \frac{MX^2}{2} + \frac{PX^3}{6} + \frac{P_1(X-1.2)}{6} + C_3X + C_4
\end{aligned}\right]\ 1.2 \quad X \quad 11.63$$

$$C_3 = C_4 = 0$$

$$\left.\begin{aligned}
EI\frac{d^2y}{dx^2} &= -M + PX + P_1(X - 1.2) - P_2(X - 11.63) \\
EI\frac{dy}{dx} &= -MX + \frac{PX^2}{2} + \frac{P_1(X - 1.2)^2}{2} - \frac{P_2(X - 11.63)^2}{2} + C_5 \\
EIY &= -\frac{MX^2}{2} + \frac{PX^3}{6} + \frac{P_1(X - 1.2)^3}{6} - \frac{P_2(X - 11.63)^3}{6} + C_5X + C_6
\end{aligned}\right]\ 11.63 < X,\ X < 32.33$$

$$C_5 = C_6 = 0$$

$$\left.\begin{aligned}
EI\frac{d^2y}{dx^2} &= -M + PX + P_1(X - 1.2) - P_2(X - 11.63) + P_1(X - 32.33) \\
EI\frac{dy}{dx} &= -MX + \frac{PX^2}{2} + P_1\frac{(X - 1.2)^2}{2} - P_2\frac{(X - 11.63)^2}{2} + \frac{P_1(X-32.33)^2}{2} + C_7 \\
EIY &= \frac{-MX^2}{2} + \frac{PX^3}{6} + \frac{P_1(X - 1.2)^3}{6} - \frac{P_2(X - 11.63)^3}{6} + \frac{P_1(X - 32.33)^3}{6} + C_7X + C_8
\end{aligned}\right]$$

$$C_7 = C_8 = 0$$

32.33 < X < 42.73

$$\left.\begin{aligned}
EI\frac{dy^2}{dx^2} &= -M + PX + P_1(X - 1.2) - P_2(X - 11.63) + P_1(X - 32.33) - P_2(X - 42.73) \\
EIY &= \frac{-MX^2}{2} + \frac{PX^3}{6} + \frac{P_1(X - 1.2)^3}{6} - \frac{P_2(X - 11.63)^3}{6} + \frac{P_1(X - 32.33)^3}{6} \\
&\quad - \frac{P_2(X - 42.73)^3}{6} + C_9X + C_{10}
\end{aligned}\right]$$

$$C_9 = C_{10} = 0$$

42.73 < X

$$EIY = \frac{-MX^2}{2} + \frac{PX^3}{6} + \frac{P_1(X - 1.2)^3}{} + \frac{P_2(X - 11.63)^3}{6} + \frac{P_1(X - 32.33)^3}{6} - \frac{P_2(X - 42.73)^3}{6}$$

Maximum Forces on legs

Bomb Rack - Side Load - (34710) (.738) = 25600 = P_1

Vert Load - (34710) (.679) = 23600

Sway Brace Side Load - (27740) (6950) = 26400 = P_2

Vert Load - (27740) (.311) = 8600

$P = 2P_2 - 2P_1 = 52800 - 51200 = \underline{1600 = P}$

$M = (25600)(1.2) - (26400)(11.63) + (25600)(32.33) - (26400)(42.73)$

$M = (25600)(33.53) - (26400)(54.33)$

$M = 858400 - 1434300 = \underline{-575900 = M}$

AT $X = 54.45$

$MX^2/2 = (575900)(54.45)^2/2 = 853,714,200$

$PX^3/6 = (1600)(54.45)^3/6 = 43,048,900$

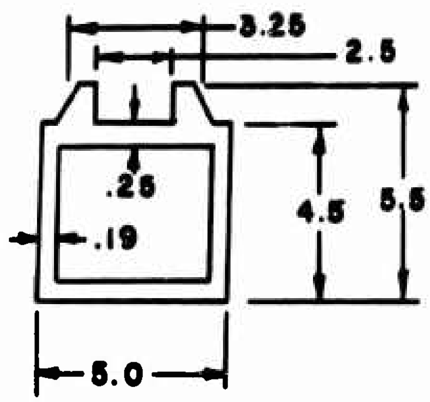
$P_1(X = 1.2)^3/6 - (25,600)(54.45 - 1.2)^3/6 = 644,239,200$

$P_2(X - 11.63)^3/6 = (26400)(43.34 - 11.63)^3/6 = 345455500$

$P_1(X - 32.33)^3/6 = (25600)(54.45 - 32.33)^3/6 = 46178500$

$P_2(X - 42.73)/6 = (26400)(54.45 - 42.73)/6 = 7082900$

$EIY = 47,278,600$ $E = 27.5 \times 10^6$



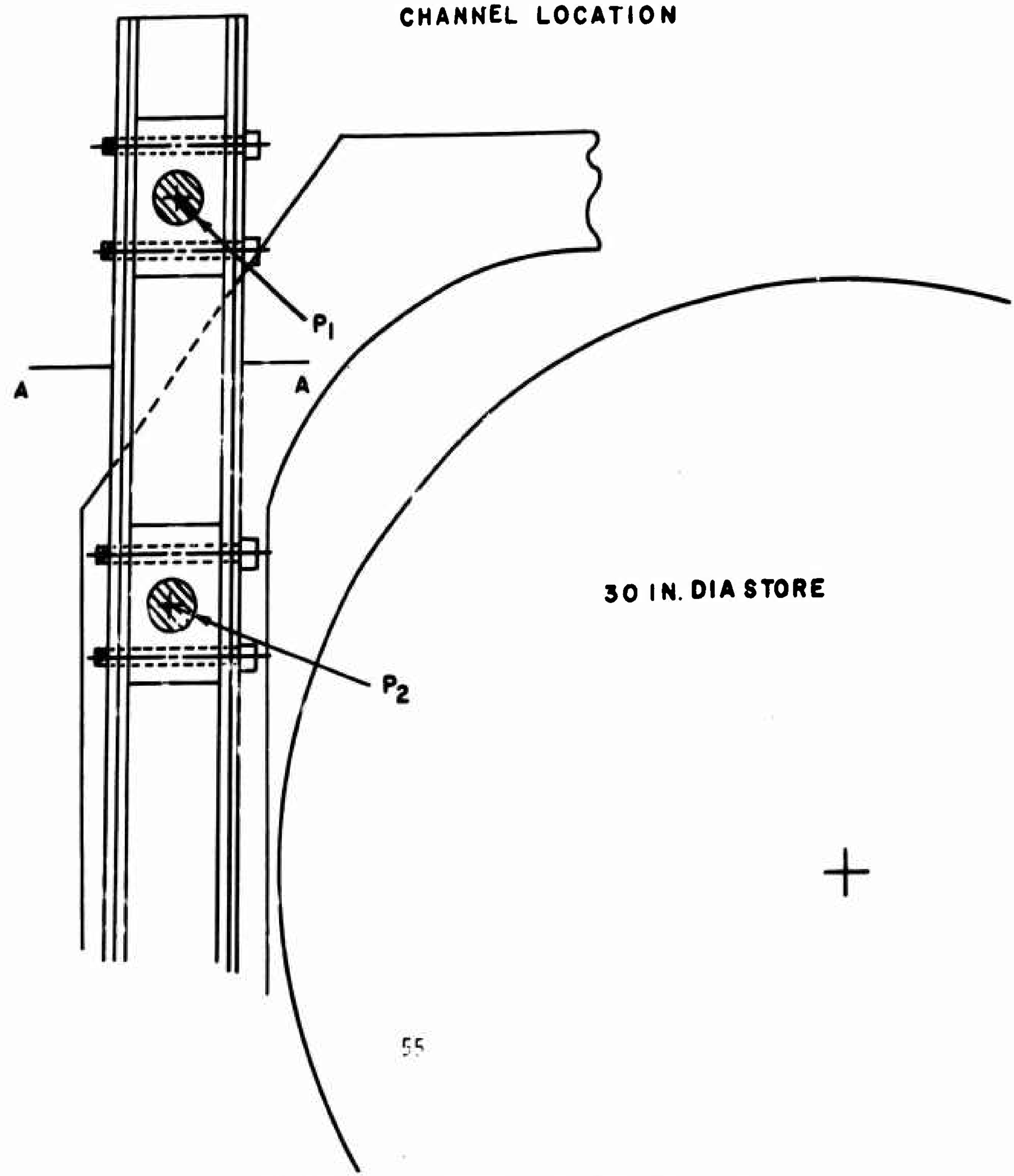
$I = (4.44)(5)^3 - (4.06)(4.63)^3 + .06(5)^3 + (1)(3.25)^3 - (1)(2.5)^3/12$

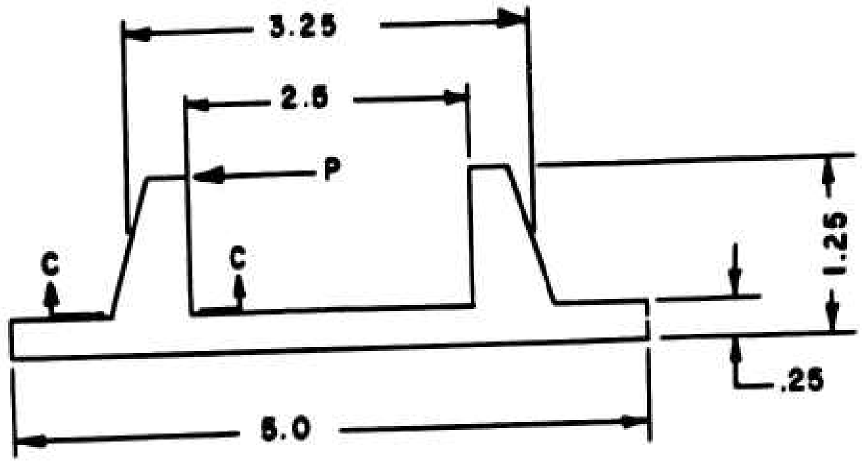
$I = (555 - 403 + 7.5 + 34.33 - 15.62/12 = 14.9$

$Y = (473 \times 10^6) / (27.5 \times 10^6)(14.9) - 1.15$ Inch

$\underline{Y = 1.15 \text{ Inch}}$

XIII. Stress on Channel





TYP SECTION OF CHANNEL

$I = (.25)(5)^3 + (1)\ (3.25)^3 - (1)(2.25)^3\ /12$

$I = (31.25 + 34.32 - 11.39(/12$

$I = 4.52$

Maximum Bending Moment on Section
A-A = (34710) (.738) (5) = 128,100

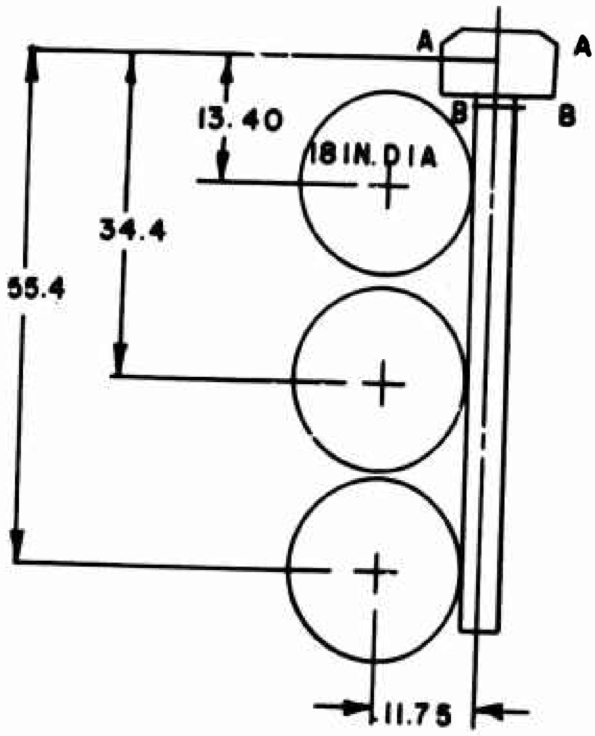
<u>Bending Stress</u> = MC/I
= (128,100) (2.5)/4.52
= <u>70,900 PSI</u>

Maximum Bending Moment on Section
C-C = (27740) (.950) (1) = 26350
Bending Stress = MC/I
= $(26350)\ (1/4)/1/12\ (4)\ (1/2)^3$
= <u>158100 PSI</u>

Maximum Shear Stress on Pins = P/A
= 23600/A
= 23600/ (4) (.196)
= 30100 PSI

XIV. Removable Leg Bending & Shear Stress

Also, see Page 8 for removable leg mounted in clip-in framework. Channel stresses for the removable leg are less than for framework legs.



Bending Moment at Section A-A & B-B for 18 Inch Diameter Stores

Upper Store -	Side Load =	(2000) (1.5) (13.4)	= 40200
	Vert Load =	(2000) (7.79) (11.75)	= 183100
Middle Store -	Side Load =	(2000) (1.5) (34.4)	= 103200
	Vert Load =	(2000) (7.79((11.75)	= 183100
Lower Store -	Side Load =	(2000) (1.5) (55.4)	= 166200
	Vert Load =	(2000) (7.79) (11.75)	= 183100
Total for Front and Rear Legs			= 858900

$I = 2(.25)(9.75)^3 + 1(3.25)^3 - 1(2.5^3)\ /12$

$- 4(.25)(.50)(4.25^2) - 4(.25)(.50)(2.75)^2$

$I = (463.4 + 34.4 - 15/6)/12 - 9.03 - 3.8$

$I = 40 - 9.03 - 3.8$

$I = 27.35$

$S = MC/I$

$S = (515300)(4.88)/27.5$

$S = \underline{91,440 \text{ PSI}}$

IV. <u>Stress Determination for Bolt & Holes Which Connect Leg to Framework</u>

It is reasonable to assume that the shear forces are proportional to the distance of the respective bolts from the centroid.

$\frac{F_2}{4.5} = \frac{F_1}{3.2} \qquad F_1 = \frac{3.2}{4.5} F_2 \qquad F_1 = .72 \quad F_2$

$4(4.5F_2) + 4(3.2)\ (.72F_2) = 515300$

$27.2F_2 = 515300$

Moment Force - $F_2 = \underline{18,900}$

Stores Force Side = (2000) (1.5) (.6) (3) = 5400
Vert = (2000) (7.79) (.6)(3) = 28000

Maximum Force per bolt < 23000

<u>Shear Stress</u> $= \frac{P}{A} < \frac{23000}{.4}$

$< \underline{57500 \text{ PSI}}$

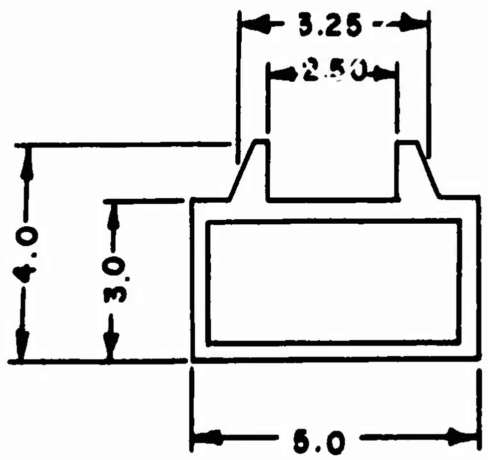
Bearing Force on metal $= \frac{P}{A}$

$< \frac{23000}{(2)(.5)(.25)}$

$< \underline{92,000 \text{ PSI}}$

Assume C.G. of store is off-center so one leg carries 60% of load.

Bending Moment = 515300



SECTION B-B

$I = (3)(5)^3 + 1(3.25)^3 - (2.56)(4.63)^3 - 1(2.5)^3 / 12$

$I = (375 + 34.3 - 254.1 - 15.6)/12$

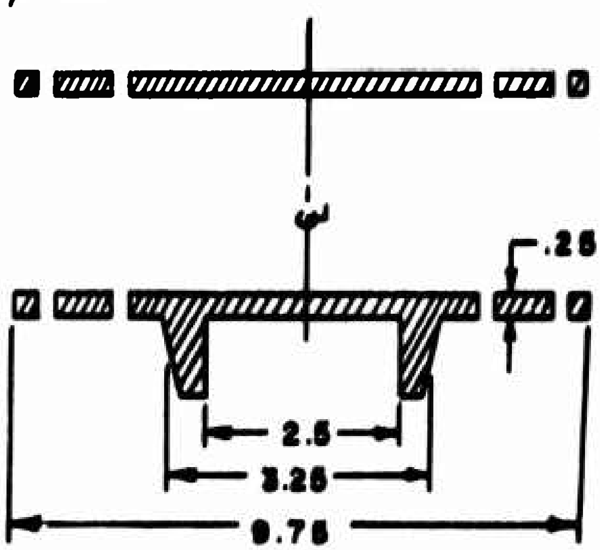
$I = 139.6/12$

$I = 11.63$

Bending Stress on Section B-B

$S = MC/I \quad (515300)(2.5)/11.63$

S 110,800 PSI



$$\Sigma F_x = 0 = F_N \cos\gamma - F_A \cos\alpha - F_B \cos\beta - F_o \cos\phi$$

$$\Sigma F_y = 0 = -F_N \sin\gamma + F_A \sin\alpha + F_B \sin\beta + F_o \sin\phi$$

$$\Sigma M_{F_o} = 0 = aF_A - bF_B - nF_N$$

Solving for F_B in terms of F_N

$$F_B = -K F_N$$

Where K is a constant. Since F_B and F_N cannot be equal to zero, they cannot occur at the same time. Therefore, there are two cases, they are:

(I) When F_y is acting upward, $F_B = 0$

(II) When F_y is acting downward, $F_N = 0$

Using these conditions in the above moment and force equations, yields,

<u>Case I</u>:

$$F_A = \frac{F_o \sin(\gamma - \phi)}{\sin(\alpha - \gamma)} \tag{3}$$

$$F_N = \frac{F_o \sin(\alpha - \phi)}{\sin(\alpha - \gamma)} \tag{4}$$

and from Figure 3,

$$F_C = F_N - F_R \tag{5}$$

<u>Case II</u>:

$$F_A = \frac{-F_o \sin(\phi - \beta)}{\sin(\alpha - \beta)} \tag{6}$$

$$F_B = \frac{-F_o \sin(\alpha - \phi)}{\sin(\alpha - \beta)} \tag{7}$$

and from Figure 3,

$$F_C = -F_R \tag{8}$$

Weight of 30 inch diameter store---------------------------4500 lbs.

	CASE I		CASE II	
	Condition 1	Condition 2	Condition 3	Condition 4
F_H	4,500 lbs.	- 4,500 lbs.	4,500 lbs.	- 4,500 lbs.
F_V	10,800 lbs.	10,800 lbs.	- 24,300 lbs.	- 24,300 lbs.

Angle	Degrees	Sine	Cosine
α	56°40'	.83549	.54951
β	13°52'	.23966	.97086
γ	44°57'	.70649	.70772
ϕ	20°40'	.35293	.93565
$\alpha-\beta$	42°48'	.67944	--
$\alpha-\gamma$	11° 43'	.20307	--
$\gamma-\beta$	21° 7'	.36027	--
$\alpha-\phi$	36° 0'	.58778	--
$\gamma-\phi$	24°17'	.41125	--
$\phi-\beta$	6°48'	.11840	--

Lever Arms: a = 10.978

b = 2.211

c = 7.680

	CASE I		CASE II	
	Condition 1 (lbs)	Condition 2 (lbs)	Condition 3 (lbs)	Condition 4 (lbs)
F_R	28,433	20,710	- 51,424	- 59,148
F_O	26,316	10,855	- 34,087	- 49,548
F_A	53,294	21,983	5,939	8,634
F_B	0	0	29,485	42,864
F_C	47,738	10,709	51,424	59,148
F_N	76,171	31,419	0	0

TABLE I

Bomb Rack and Sway Brace Loads at C.B. of the Store

	Case I		Case II	
	Condition 1 (lbs)	Condition 2 (lbs)	Condition 3 (lbs)	Condition 4 (lbs)
$F_{R,1}$	16,882	12,297	- 30,533	- 35,119
$F_{R,2}$	11,551	8,413	- 20,891	- 24,029
$F_{C,1}$	28,643	6,425	30,854	35,489
$F_{C,2}$	19,095	4,284	20,570	23,659
$F_{N,1}$	48,356	19,946	0	0
$F_{N,2}$	27,815	11,473	0	0
$F_{o,1}$	15,625	6,445	20,339	29,419
$F_{o,2}$	10,691	4,410	13,848	20,129
$F_{o,A}$	16,706	6,891	21,639	31,455
$F_{o,B}$	9,610	3,964	12,448	18,093
$F_{A,1}$	33,833	13,955	3,770	5,481
$F_{A,2}$	19,443	8,020	2,167	3,150
$F_{B,1}$	0	0	18,718	27,211
$F_{B,2}$	0	0	10,757	15,638

TABLE II

Bomb Rack and Sway Brace Loads

UNIVERSAL CLIP-IN

SWAY BRACE AND BOMB RACK FORCE CALCULATIONS

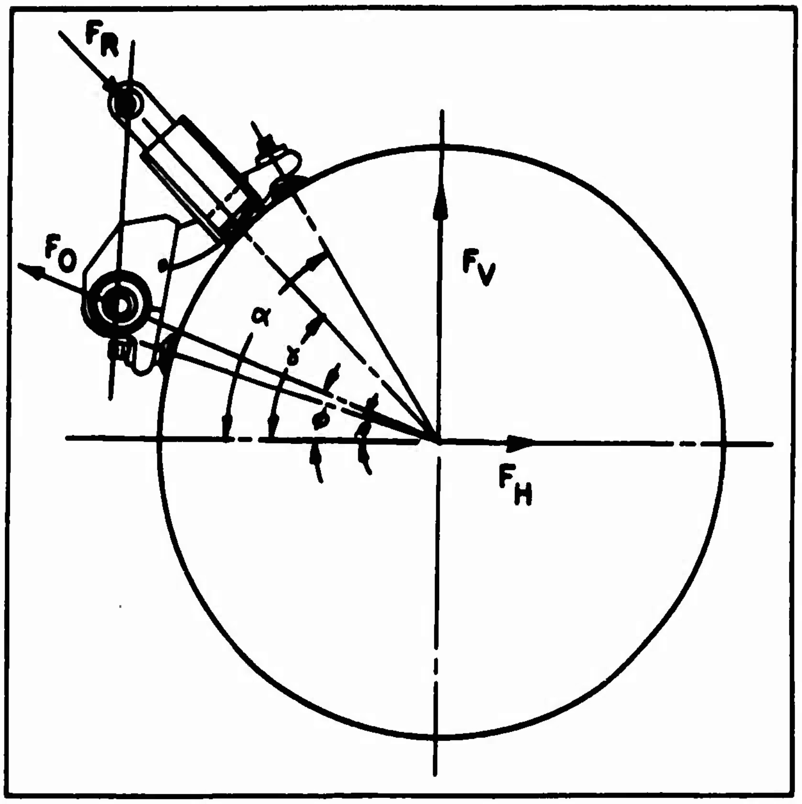


Figure 1
Assembly

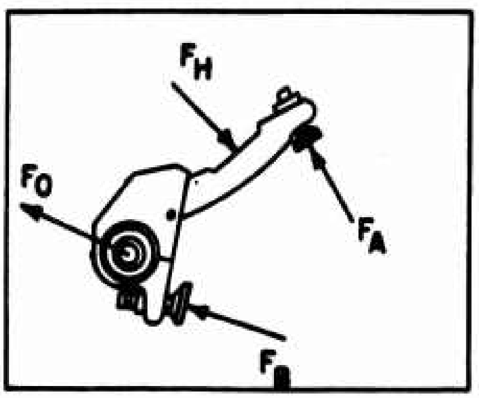


Figure 2
Sway Brace

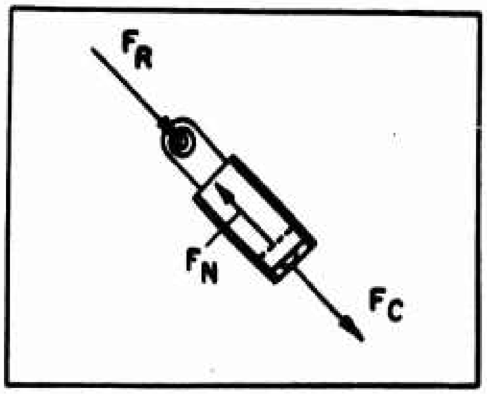


Figure 3
Bomb Rack

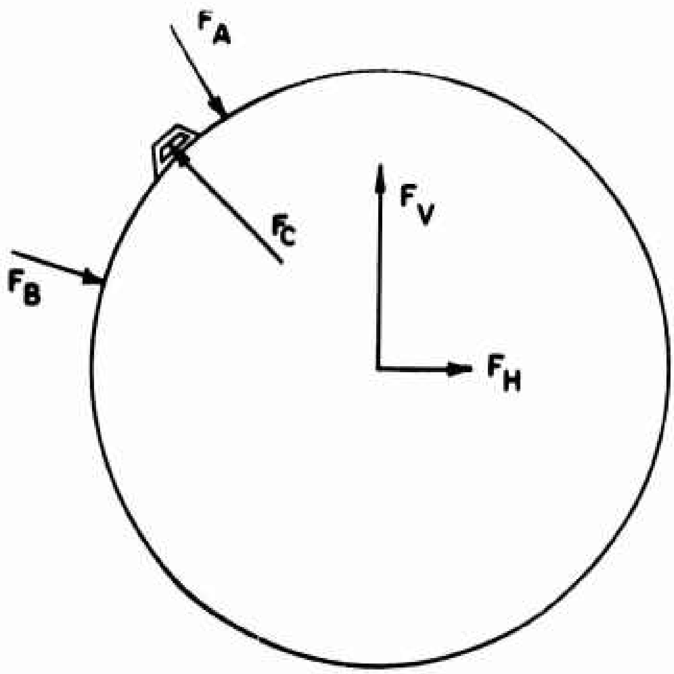


Figure 4
Store

Summing the forces in the X and Y direction for Figure 1 yields,

$$\Sigma F_X = 0 = F_R \cos\gamma - F_o \cos\phi + F_H$$

$$\Sigma F_Y = 0 = -F_R \sin\gamma + F_o \sin\phi + F_V$$

Then solving for F_R and F_o in terms of F_H and F_V,

$$F_R = \frac{F_H \sin\phi + F_V \cos\phi}{\sin(\gamma - \phi)} \tag{1}$$

$$F_o = \frac{F_H \sin\gamma + F_V \cos\gamma}{\sin(\gamma - \phi)} \tag{2}$$

The force and moment equations for the sway brace (Figure 2) are,

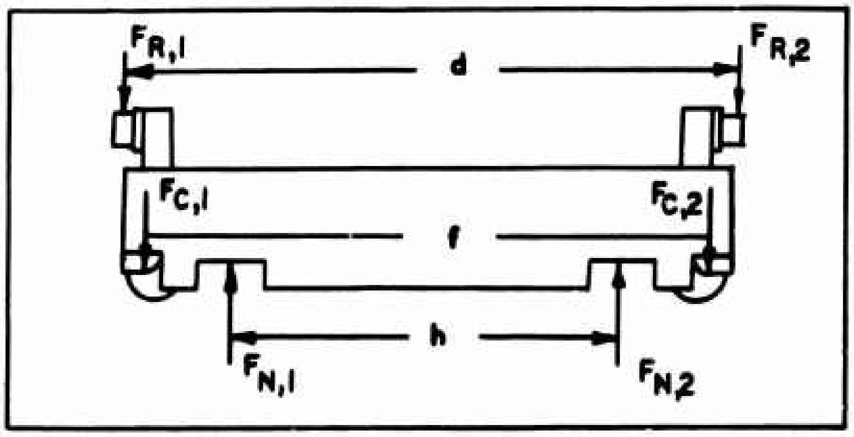


Figure 5
Bomb Rack

The values in Table I are computed at the center of gravity of the store. For further calculations it is assumed that the loads on the store's lugs have a 60-40 percent distribution. That is, the C.G. of the store is located 12 inches to the right of $F_{C,1}$ and 18 inches to the left of $F_{C,2}$.

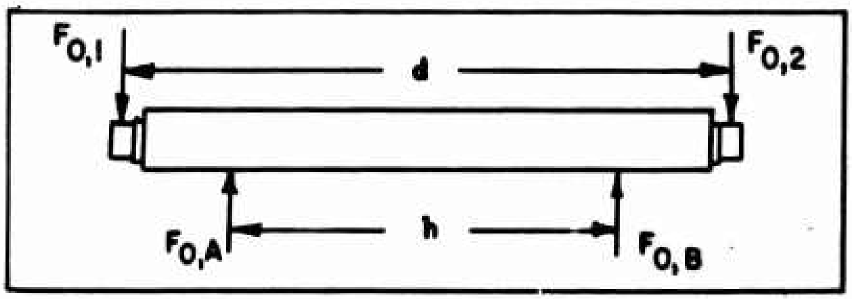


Figure 6
Sway Brace

Given: d = 32.00''
f = 30.00''
h = 20.25''

$F_{o,A} = f(F_{A,1},\ F_{B,1},\ + F_{N,1})$

$F_{o,B} = f(F_{A,2},\ F_{B,2},\ + F_{N,2})$

The solution for the forces in Figures 5 and 6 may be seen in Table II.

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13. ABSTRACT

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This final report summarizes the engineering effort of Rock Island Arsenal to design a Universal Clip-in and associated equipment for the Air Force Weapons Laboratory (AFWL), to accommodate a variety of types and sizes of stores. Systems components and the problems inherent in designing them are described. Operating instructions are specified. The RIA test program is outlined and the results and chief features of the device are presented. This Universal Clip-In meets the Air Force requirements, and has been designated as the MHU 79/C Clip-In Assembly.

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Bomb racks						
Bomb suspension system						
Bomb release system						
Design calculations						
Bomb sway braces						
Bomb loading equipment						
Universal Clip-In						
B-52 Clip-In Subassembly						